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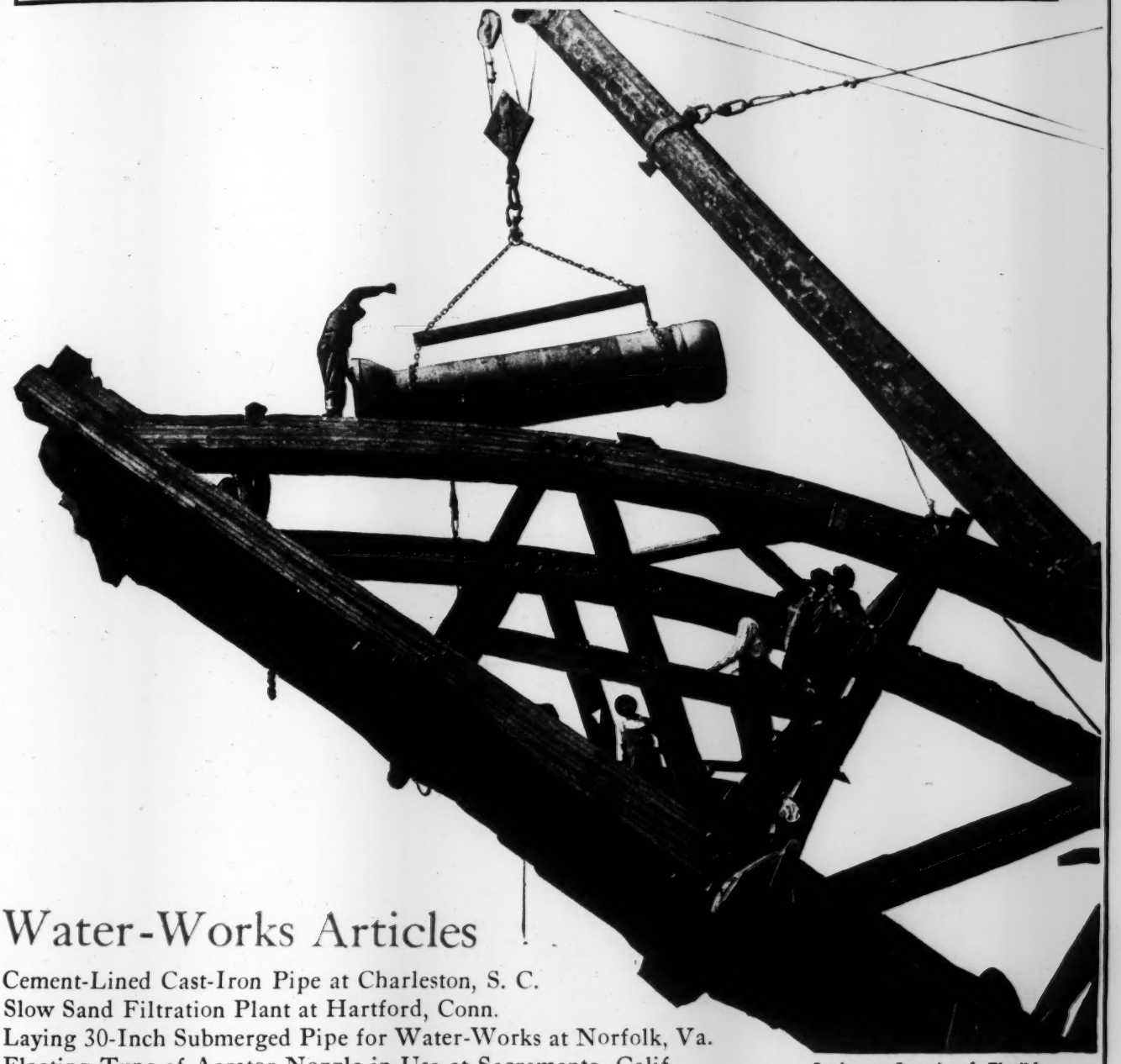

Setting a Length of Flexible-Joint Cast-Iron Pipe in a Laying Cradle on Elizabeth River Crossing, Norfolk Water-Works

Water-Works Articles

Cement-Lined Cast-Iron Pipe at Charleston, S. C.
Slow Sand Filtration Plant at Hartford, Conn.
Laying 30-Inch Submerged Pipe for Water-Works at Norfolk, Va.
Floating Type of Aerator Nozzle in Use at Sacramento, Calif.
Prechlorination-Alum Treatment of Soft Waters

Monthly Labor and Material Prices

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

Volume 89 — NEW YORK, SEPTEMBER 7, 1922. — Number 10

An Enemy of the People

GOMPERS has often maintained that labor should not be limited by the law. And he always runs true to form. The government demands protection of workers against violence and intimidation. Gompers counters with talk of a general strike. The government asks only that illegitimate action be enjoined. Gompers threatens to punish the whole country if it is.

When are we going to be free from his poisonous, justice-destroying rant? He should be supporting the government's efforts. Did he not see red whenever a labor matter is in the courts he would know that his best road to public favor is by quashing the dynamiters, the thugs, the murderers and the intimidators in his own ranks. These are the people who block the labor movement and raise up enemies against it among even the people who are naturally favorable toward the wage earner—the farmers and the people in commercial life, who have no direct contact with industry, mining or the railroads.

But Gompers was raised on rant—and lives by it. The Federation needs a leader who, besides being a hard fighter and an able champion, is clear-headed and strong enough to force his own people to square their conduct with the rights of others. A Theodore Roosevelt in labor's ranks would be a God-send to labor and to the country.

The Temporary Injunction

BUT WHILE condemning Mr. Gompers' outburst we also entertain grave doubts as to the wisdom of enjoining free speech—and that the temporary injunction would seem to do. We realize that simple persuasion easily becomes intimidation, but we must lean over backward when fundamental rights are in question. Nevertheless, that does not condone Mr. Gompers' tirade. He will have his day in court Sept. 11. His present violent expression not only prejudices labor's case but breeds disrespect for the law.

Water-Works Problems and Practice

THE NUMBER and diversity of problems and practice in the water-works field is illustrated by the articles on succeeding pages published in recognition of the convention of the New England Water Works Convention at New Bedford, next week. As time goes on and the arts and sciences tributary to the efficient design, construction and operation of water-works advance, the demand for engineers, chemists, biologists and managers in this great field will also increase, and the increased demand for trained men will be in more than an even ratio with the advance in the tributary arts and sciences, because with the latter there will be an accelerating public demand for water of higher quality and for better and surer service.

A Sign and a Promise

AN INDEX of our civilization that is both a cause for regret and a promise of better things is the motorized laboratory for work among summer resorts operated by the Michigan State Board of Health. "Vacation typhoid" has long been a familiar term of indictment of rural and resort sanitation. A man from Mars would exclaim at the anomaly of city dwellers going to the mountains, the riverside, the seashore or "the good old farm" for their health and thus contracting typhoid. Happily this risk is lessening, thanks to an increase in general intelligence in town and country and to organized public health work, but unhappily there is still much need of improvement.

Why Hartford Chose Slow Filters

NEW ENGLAND has clung to relatively pure sources of supply rather than adopt water treatment and when treatment has been considered advisable, slow sand rather than mechanical filtration has been the rule. This has caused outcry elsewhere but the New Englanders go placidly on. Moreover, they advance reasons, based on regional conditions and local preferences and supported by statistical and other data, that deserve consideration. Witness Mr. Saville's exposition of why Hartford recently built slow sand rather than mechanical filters and his comparison of the cost of the Hartford slow and Cambridge rapid filters. Eventually the strong feeling against mechanical filtration may disappear in New England, as it has in most other parts of America. Until then—and probably until other local conditions than sentiment have also changed—the New England tradition against mechanical filtration and against chlorination as well, will be given weight by engineers who realize the need for recognizing local conditions—particularly the human factor.

Cement Prices

FRANKNESS is, after all, the best approach to controversial subjects. For several years there has been much question as to the reasonableness of cement prices. In particular, a contractors' group, under the leadership of the A.G.C., has declared that they have been too high. Now comes Mr. Burch, of the Atlas Portland Cement Co., and in a frank inquiry lays the pertinent facts on the table. The exposition is satisfying. He studies prices from three different angles: the earnings of the cement companies, the cost of production, and the comparison of prices of cement with those of other building materials. Nor does he dodge in his study of earnings. He plots the returns of the two most profitable eastern companies and of the two worst losers. In giving details of cost of production he shows profit, too. Of course, everyone knows that there is great latitude in what different people might

include in costs, with the consequent effect on profit, but it must be remembered that accounts are now under federal income-tax scrutiny and the percentages written off for depreciation and amortization definitely set. In other words, today's industrial figures are not subject to the variation of personal opinion as they were ten years ago. Mr. Burch's frankness should have more frequent imitation. The public's confidence is the best assurance of business stability and freedom from public persecution. Confidence can be won in large part through such frankness as that displayed in Mr. Burch's inquiry.

Cement-Lined Cast-Iron Pipe

THE use of cement lining to protect the interior of ten miles of cast-iron water mains at Charleston, S. C., promises to be a happy union of a lining and a pipe which, independently, have stood the test of time. For cast-iron pipe leads the materials used for water mains in point of long and universal use and for many decades cement has been extensively used to protect wrought-iron and steel pipe. In fact, cement-protected wrought-iron pipe, both in point of invention and use, antedates tar-coated cast iron by a decade or more. Thus, although a United States patent for cement lining was granted to Jonathan Ball in 1843 and cement-lined wrought-iron pipe was laid by Jersey City, N. J., and by Rockville, Conn., in 1845, it was not until 1849 that Dr. Angus Smith developed his tar coating in England and not until 1858 that it was introduced in America by James Kirkwood. With this lead for protection of wrought-iron pipe, why cement was not used to line cast-iron pipe until 1922 is an interesting question.

The answer lies largely in the fact that cement lining for sheet-metal pipes came into use because for many years these pipes were much cheaper than cast iron but would soon be destroyed without the cement lining and exterior coating invented by Ball and improved later on by Phipps and others. Already in 1858, when Kirkwood introduced Smith's coating, cast iron, *uncoated*, had been in continuous service in this country for a half century and much longer in England and France, and was destined to have a further life not yet determined. In some waters the uncoated pipe rapidly lost carrying capacity through corrosion or incrustation but the physical integrity of the pipe remained. When the tar and linseed-oil coating developed by Angus Smith here, came to the front and for years afterward, it was cheap and of such a quality as to be generally efficient. As the decades passed and water-works and the population they supplied increased rapidly, less desirable sources of water supply were pressed into service. Some of these waters were highly corrosive, so that the lessening diameter, smoothness and carrying capacity of water mains, due to corrosion, combined with the increased demand for water from the same mains, created a need for a better coating than tar and linseed oil. The need is now all the more acute because the general substitution of water gas for coal gas and the increasing industrial demands for tar have resulted in poorer tar coatings than in earlier days. The great increase in water treatment in the past decade or two has added to the corrosion problem, through increasing the corroding and incrusting qualities of some waters.

Cement-lined pipe, first with wrought-iron and latterly with steel as the sheet metal used, soon demonstrated and has since maintained its superiority to tar-coated cast-iron pipe so far as ensuring undiminished interior diameter and smoothness, and thus constant carrying capacity, is concerned. At least this is true where good workmanship in the lining process and neat *natural* cement instead of cement mortar of a possibly nondescript character have been the rule. Poor material carelessly applied leads to failure of the cement lining in spots if not in large areas, thus giving the water access to the thin sheets of wrought iron originally used and the cement-lined steel customarily employed for some two or three decades past. These and other causes brought cement-lined sheet-metal pipe into general disrepute many years ago, except under favorable local conditions and where the pipe was made by improved methods—as at Plymouth, Mass., by the town and for use elsewhere by a pipe manufacturing company. Those who wish to pursue further the history of cement-lined sheet-metal pipe will find a long and valuable paper, by Leonard Metcalf, supplemented by an extended discussion, in the *Journal* of the New England Water-Works Association for January, 1909.

The chief weakness of a combination of cement and sheet iron or steel would be absent in a combination of cement and cast iron. The principal weakness of cement-lined sheet iron or steel was—its weakness; in other words, the thinness of the metal and the fact that the cement was for protection rather than added strength. The argument for cement-lined cast-iron pipe lies, first, in the thickness and ample strength of the metal and, second, in the proved value of cement when properly applied to the water-exposed and friction-causing interior surface of wrought iron and steel. True, there is as yet no experience as to the lasting adhesion of the cement to the cast iron, but there seems to be no reason why it should not adhere at least as well to cast as to rolled metal.

Considering costs, it should be noted that the cost of lining the interior of cast-iron pipe with cement will be much larger than of coating both the interior and exterior with tar; so much larger that the tar coating might be much improved as to the material itself, its preparation and its application, and the cost still be much less than that of cement lining. Against the increased cost for cement lining must be placed the greater carrying capacity of the pipe after a longer or shorter time of service. This, in turn, will depend largely upon the corroding or incrusting character of the water being conveyed.

Reverting to Charleston, the water there is so very corrosive as to cause a rapid decrease in carrying capacity of tar-coated cast-iron pipe; a decrease speedily repeated after the pipe is cleaned. Under such conditions heroic measures are demanded and even a costly preventive of the trouble is warranted.

When and where to resort to water treatment to prevent corrosion or incrustation of water mains, how far to depend upon cleaning as a palliative, to what extent a choice among pipe materials and pipe coatings will avert trouble, and what combinations of these possibilities may prove wise are questions which in the future will more and more frequently confront the water-works engineer. Today, thanks are due the engineers and other officials of Charleston and the co-operating pipe manufacturers for the large-scale trial of cement lining for cast-iron pipe upon which that city is entering.

Publicity Run Mad

SEVERAL weeks ago we questioned the wisdom of reliance on the press-agent to win for the engineering profession that measure of public standing which so many feel is its due. We dwelt then upon its futility. The matter has, however, a darker aspect which recently has become more and more pronounced, until now it is so obvious that it can no longer be overlooked. This is the positive danger that is incurred by a professional society that embarks upon a policy of instigated publicity.

No one can object to a press-service or to the press-agent so long as he is restricted to his legitimate function of purveying the genuine and uncolored news of a technical society. This is a real service, of value alike to the society, to the press and to the public at large. No one can object, moreover, to a society press-service that under the curb of technical guidance and restraint submits for publication news of popular interest concerning engineering developments aside from the doings of an individual society or group. Legitimate technical publicity work has been defined as "doing something and then telling about it," and so long as the telling is honestly done we have not the slightest quarrel with such a practice. The dangers lie in the perversions of this legitimate and worth-while activity. These at first may seem quite harmless but eventually they will strike at the root of the professional standards that are in the keeping of the professional societies.

These perversions take three forms. The first is the relatively venial offense of making much ado about nothing. Sometimes the unfortunate press-agent feels that he must make bricks without straw; he must "tell about it" even though his society-employer has not "done something." This comes about, of course, because he is judged by the frequency with which he "lands," that is to say, gets into the press some mention of the organization that is paying him. His constant temptation, therefore, is to invest with a fictitious importance the most commonplace incidents in the affairs of the society and to palm them off upon the napping editor as "news" worthy of a place in his journal. What are the results? The editor and the public are harmlessly fooled, the vanity of the society is measurably tickled, and the press-agent carefully preserves the clippings against the day that he shall be called to account for his stewardship and perchance negotiate a new retainer. But the observant will smile, the society will look silly to those who really matter, and the judicious will grieve that a professional society should be willing to be made ridiculous.

This tendency, harmless enough in itself perhaps, often leads to the second and more serious offense of misrepresentation. This usually does not take the form of flat misstatement, although there are not lacking instances even of that, due in most cases, more to inadvertence than to intent. We mean rather the deliberate and subtle creation of false impressions in the public mind. Truly these may be of little moment to the public and may inflict upon it no material injury of any description. But they are nevertheless deceitful, and in proportion as they mean little to the public, their publication means little to the society or to the profession it affects to represent. For example: In connection with a dinner held recently under the auspices of a professional engineering society, advance press notices circulated under the name of the society, announced that "distinguished engineers, publicists and educators from many cities will attend." Among the "invited guests" were listed some twenty-two names including Charles M. Schwab, General George W. Goethals, Henry R. Towne, Gerard Swope, and General E. O. Squier. As a matter of fact, fifteen of the twenty-two invited guests including these five, were not at the dinner. In another instance notices similarly supplied to the press were so framed as to create the impression that an officer of the society in question was included in an official party headed by a cabinet officer. It was so effectively done that at least one daily newspaper featured that statement in its headlines.

These are typical press-agent stunts. No more classic dodge is known to the newspaper craft than to tie up, by hook or by crook, with the names of celebrities having news value.

But, it may be asked, what harm has been done? How has the public been injured by being thus imposed on? That is not the point. The injury is inflicted upon the society and upon the profession it is supposed to represent. No profession seeking to win and retain public confidence ever will achieve it through imposition and deception, however carefully it may be sugar-coated and however harmless may be the immediate effect.

The third and perhaps the most vicious of the dangers we have in mind is the perversion of the press-service activities to unfair propaganda. This sometimes takes the form of boosting the society that employs it to the prejudice of others in the same field. This is particularly noticeable in connection with joint undertakings, when the loyal and discriminating press-agent is prone to supply "news" that plays up the part of his employers and subordinates or ignores entirely the contribution of those who may be associated with them. An even more hateful variety of this perversion is the promotion of individuals who may for one reason or another, be close to the source of publicity. An obvious characteristic of much technical press-service is to play up strongly the names of individuals, focusing attention by devices well known to newspaper men. A regular perusal of some of this material, moreover, will impress upon even the casual reader, the names of a very few who are regularly "among those present." This also will bear watching, to the end that an organization press-service may not become the instrument of individual ambition.

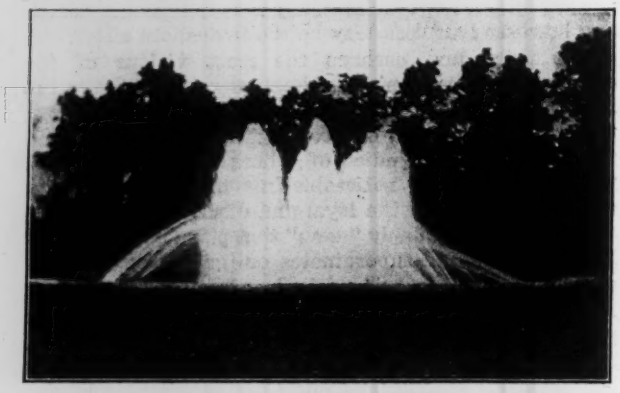
All these are very real dangers that lurk in the channels now being followed by a number of technical and professional societies. We point to them without the slightest intention to criticise or to discourage the dissemination by such societies of technical and society information, provided this be done accurately, honestly and with dignity, having in view always the real needs of the community and the establishment in the public confidence of the ideals and practice of the profession. The public cannot know too much about the work of engineers and the service rendered by the societies. But every professional society—especially those that publish codes of ethics for the guidance of their members—should examine closely and critically the activities of their press-services and square them with the principles laid down in those codes. Is not this a fair standard? Or are professional societies now to be devoted to circumventing in behalf of the group, the ethical obligations that they seek to impose upon the individual?

Slow Sand Filtration Plant for Hartford, Conn

Slow Rather than Rapid Filters Chosen After Careful Study in Which Color Was Chief Mooted Question —Costs Compared with Rapid Filters at Cambridge

By Caleb Mills Saville
Manager and Chief Engineer Water Department, Hartford, Conn.

HARTFORD, CONN., put in operation in February of this year a slow sand filter plant having a capacity of 17.5 m.g.d. which has since given satisfactory service. The plant is notable because it is one of the latest and larger slow sand filters in this country, decided upon after careful study of the relative merits of slow and rapid filters at a time when slow filters for new plants are not often built. It therefore seems desirable to put on record the reasons why slow sand filtration was adopted at Hartford and to outline the main features of the design of the plant. At the close of the article the unit costs of the Hartford slow sand filters and of the new rapid sand filters for Cambridge, Mass., which are nearly as large (14 m.g.d.) are compared. It may be added that the possibility of producing a water of a color satisfactory to the people of Hartford was the one question really at issue at Hartford in deciding which type of filter to adopt, so strong was the local sentiment in favor of slow sand filtration and of avoiding the use of chemicals. The opinion of several experts was sought. Much weight was given to the color forecasts and opinion of the late Frederic P. Stearns.



AERATOR AT HARTFORD SLOW SAND FILTRATION PLANT. THE BASIN IS ABOUT 40 FT. IN DIAMETER

The Hartford Water Supply—Hartford has two independent but interconnected sources of water supply. One, which is the major portion of the older system, drains from the easterly slopes of Talcott Mountain and is about six miles distant from the center of the city. Here there are four collecting reservoirs with a total capacity of about 1,200,000,000 gal. in which is stored the runoff from about 5.5 sq. miles of collecting area. Three of these reservoirs drain into the fourth, known as No. 5, which also acts as a receiving and balancing basin for both systems.

The second supply source is the new one recently completed, called the Nepaug. This is located about 10 miles northwest of the older supply, near the Village of Collinsville, Conn. Here there has been built a reservoir of about 9,560,000,000 gal. capacity which receives the runoff from about 32 sq. miles of very sparsely inhabited upland the major part of which is covered with forests.

The estimated safe yield of this source is 32 m.g.d. The water is brought to West Hartford through about 10 miles of aqueduct consisting of cast-iron pipes, concrete grade conduit, tunnel and concrete pressure pipe, having a present capacity of about 30 m.g.d. This conduit also discharges into Reservoir No. 5, the receiving basin spoken of above.

The purification plant is located about one-third of a mile south of Reservoir No. 5 and the supply of water for the plant is taken from the pressure conduit through a gate chamber so arranged that water may be taken at will from either source or from both at the same time in any proportion desired. The object of this is to permit of using the best water from all of the sources.

The control is so arranged that when water is being drawn from the Nepaug source any surplus will automatically discharge into Reservoir No. 5, and in case of break in the conduit supply, water from that reservoir will automatically be supplied to the filters for the city consumption.

Amount of Water Required—Hartford is now using about 13.5 m.g.d. With the present rate of increase the rated capacity of the filter beds now built will be reached in about seven years. High construction costs made it seem inadvisable to build for further into the future, but provision was made to double the filter capacity now available, which would bring this portion of the plant up to the estimated safe capacity present sources, with the additions made by separate units as required. Still further growth has also been anticipated in a general plan for expansion, when the present plant can be duplicated or combinations made with other methods if future developments in water purification should make such a course advisable.

The average daily per capita use of water in Hartford now is about 81.5 gal. for all purposes. Possibly this consumption can be somewhat reduced.

The supply of water safely available from the combined sources, estimated from the yield of those periods of low rainfall that come once in half a century or more, is put at about 37 m.g.d. Such an amount, at present rates of increase in consumption, will be sufficient until about 1950, at which time the final payments will have been made for retiring the bond issue that provided the funds for financing the new supply. In this way the generation having the use of the water will pay for it, leaving no burden on the future for a plant that has reached its life.

Ordinarily it is planned to use water from the Nepaug source, holding in reserve the water in the older reservoirs for use in case of accident to the conduit or other interruption of this supply, which would be sufficient for about three months' service at present rates.

Character of the Water—The older water gathering

source was on the slope of a basalt dyke which had broken through the triassic sandstone and shale formation that now flank its sides. Due to the mineral content of this area the water, although soft compared with that used in many parts of the country, was relatively hard in comparison with surface water flowing from areas where the metamorphic rocks and the glacial gravels predominate. The water supplied from this source showed a color of from 11 to 50 p.p.m. for about 83 per cent of the time, with monthly means ranging from 24 to 45 and an annual average of about 33. For turbidity the median of the several years studied was 8 p.p.m. with a monthly range of 4 to 14. Mean monthly hardness ranged from 29 to 38 p.p.m. with an annual average of 34.

For the new supply the color averages about 26; turbidity, 2 to 4; hardness, about 16. The reservoir from which the water comes was unstripped and was filled for the first time about November, 1917. What would be the color, turbidity and hardness of the new water was unknown when the first studies were made for the purification plant, the report with recommendation being also made the first part of the same month and year that the reservoir was first filled.

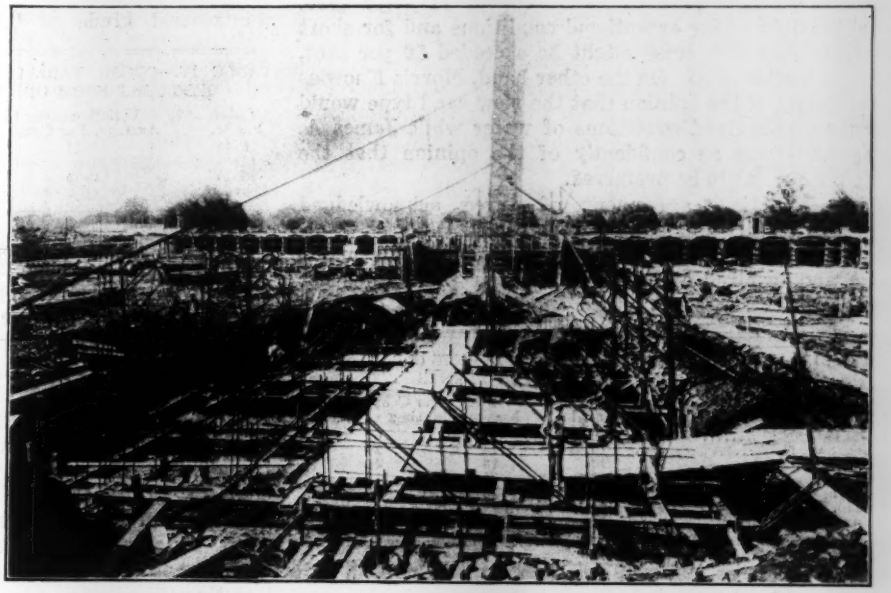
At first, a rapid sand plant only was considered, but after careful study of the character of the water to be expected from this source and after consultation with many of the best-known specialists in the country, half of whom were firmly of the opinion that the rapid sand type of filter would give the most satisfactory results, it was finally decided to install slow sand filters. It is only fair to say, however, that those in favor of the rapid type freely acknowledged that the slow sand filter under Hartford conditions would probably give a satisfactory water most of the time.

The late Frederic P. Stearns, who had acted as consultant throughout the whole of the additional supply work, was firmly of the opinion that the slow sand type was the most suitable for Hartford conditions. Mr. Stearns was particularly interested in the color phase of the problem and brought to it the whole force of his keen analytical mind. As a result of his studies of the problem, Mr. Stearns prepared the accompanying table of monthly colors that might be expected in the water from the Nepaug reservoir for the period 1917 to 1923 and gave his opinion of the probable color that would be likely after the reservoir had been in use for 8 or 10 years and had become conditioned. The close agreement of these figures with those from actual observation since is only one more testimonial of the remarkable grasp of condition and of the prescience shown by Mr. Stearns in all of the work which he undertook.

In regard to these colors Mr. Stearns said: "The conclusion which I reach from the further study I have made of the probable colors in the Nepaug Reservoir, after it has reached its normal and permanent condition as regards color, is that the maximum color will vary only a few points, generally not more than 3 or 4 from the average of the year."

In the consideration of the type of filter to be installed, the matter of the ultimate color of the water to be supplied to consumers became finally the principal one to influence decision, and this was debated at length by the commission. The specialists who favored the rapid sand process were united in their opinion that a water for domestic use should have a color not much exceeding 10, and that with proper operation of a rapid sand plant, including constant use of one or more chemicals under continual trained technical supervision, such a water was possible of attainment.

As regards slow sand filtration, with some reservations for unusual occurrences, the concensus of opinion among the consultants was that with Hartford water the reduction of color attainable would be about one-third of the applied water.



HARTFORD SLOW SAND FILTERS UNDER CONSTRUCTION

Concrete pouring plant and filter structure in rear. Office foundation in foreground.

Four of the reservoirs of the older system were retained in use, and the characteristics of the waters of these were carefully considered as to the possibilities of mixture with the new supply in order to send as low colored raw water as possible to the filters. Reservoir No. 2, with a storage of 284 m.g., and a drainage area of 1.4 sq miles, has an average color of 26, a minimum of 13, and an ordinary maximum of 36, exceeding this on one monthly examination in ten years with 54. Reservoir No. 6, with a storage of 800 m.g., and a drainage area of 2.4 sq. miles, has an average color of

TABLE I. STEARNS' NEPAUG WATER COLOR FORECAST, P.P.M.

Year	Average Annual Color	Monthly Range
1917	38	24 to 58
1918	36	28 to 44
1919	30	27 to 37
1920	27	23 to 31
1921	25	21 to 29
1922	24	20 to 28
1923	16	17 to 24

19, a minimum of 11 and an ordinary maximum of 28.

A summary of the estimates made by the specialists of what colors might reasonably be expected with Hartford water, slow sand filtration, reduction of color one-third and no chemicals is shown by Table II. G. W. Fuller, however, feared that in some years the annual

TABLE II.—NEPAUG WATER COLOR ESTIMATES MADE BY STEARNS, FULLER AND WESTON, P.P.M.

	Average Annual			Maximum for Month at a Time	
Year	F. P. Stearns G. W. Fuller	R. S. Weston	F. P. Stearns	R. S. Weston	G. W. Fuller
1919	18	22	18	28	27
1920	17	20	18	25	26
1921	16	19	17	23	24
1922	15	18	17	22	23
1923	14	17	16	21	21
1928	11	13	14	20	16

average might be 30 per cent above the ordinary average. That is a color of 14 instead of 11 after 1928, and possibly under exceptional conditions and for short periods even this color might be exceeded 50 per cent, giving a color of 21. On the other hand, Morris Knowles was firmly of the opinion that the slow sand type would best suit Hartford conditions of water while James A. Newlands was as confidently of the opinion that the rapid type was to be preferred.

The practical agreement of three acknowledged authorities in water supply work (Table II), each working independently of the other, was somewhat remarkable and inspired a confidence in their predictions not usual in forecasts of future conditions. All of them

TABLE III.—VARIATIONS IN COLOR OF EFFLUENTS (P.P.M.) FROM SEVEN RAPID SAND FILTER PLANTS

Name of Plant	Average Annual	Monthly Maxima	Per Cent Monthly Maxima of Average
Little Falls, N. J.	9	15	67
Watertown, N. Y.	14	18	29
Newport, R. I.	10	14	40
Akron, Ohio	12	26	112
Trenton, N. J.	10	20	100
Toledo, Ohio	16	36	125
Warren-Bristol, R. I.	12	16	33

agreed that the average color to be expected in the effluent of a slow sand plant after the reservoirs became conditioned (9 or 10 years after filling) would be between 11 and 13, or a weighted average of less than 12, while the maximum color to be expected varied only by about 6 p.p.m. The highest color to be feared by any of them was 21 and this only in event of an unusual combination of circumstances. The average color expected by even the rapid sand advocates, after conditioning of the reservoirs, therefore, varied only by from one to three points from that color which was considered an ideal one, and such variation is ordinarily discernable only by trained observation in a laboratory.

To know what was the color of the water supplied from some of the rapid sand plants running under what may be considered as practical operating conditions, inquiries were sent to a number of such plants. The replies are summarized in Table III. The average monthly variation from the average in these plants is 72 per cent, with a range of from 29 to 125 per cent.

Daily color variations in these plants run much higher. For example, in one of them the deviation from the average was as shown in Table IV. It was reported by the Water Department at this place that there were no complaints from consumers nor any demand for a water of less color. At another plant producing an effluent of color 4 the daily maxima for the past five years (1913-18) had run to 30, an increase of 640 per cent, while at still another, with an annual average of 12, the daily average maximum often rises to 20.

Reports from 18 of the well-known rapid sand filtration plants of the country gave an average for the year of 11.2, a maximum of 24, and a minimum of 4. Referring to the predicted colors obtainable in the case of Hartford with slow sand filtration, an average of 11.7 and a rare maximum of 21, it would appear that with some New England waters, at least, color removal results to be obtained with the two types of filters are strictly comparable.

As is often the case, the general opinion of the consumers, who had long been accustomed to having their water drawn from several beautiful reservoirs attractively set in an uninhabited woodland park, the outspoken opinion was very much in favor of a "water just as nature supplied it filtered through sand" and without the several kinds of "dope" always necessary to a

TABLE IV.—COLOR VARIATIONS (P.P.M.) FROM AVERAGE IN EFFLUENT FROM ONE RAPID SAND FILTER PLANT

Color P.P.M.	Variation from Average, Per Cent	Duration During Year in Days	Per Cent of Year	Equivalent Weeks
6–11	63–31	35	9.6	5
12–15	25–0	238	62.5	34
16–25	0–56	47	12.9	7
Above 25	56 and over	45	12.3	6

greater or less degree with rapid sand plants. This opinion was the stronger because of the active backing it received generally from the physicians of the city. Hartford wanted a "pure and wholesome water" and Hartford in all its works has placed results above cost.

What are the requirements of such a water? In his book, "Value of Pure Water," Professor Whipple states that such a water should be free from poisonous substances, free from bacteria or other organisms carrying disease, must be practically clear, colorless, and odorless, and reasonably free from chemical salts in solution and from microscopical organisms in suspension. As a result of his study, Professor Whipple concluded that with a color of less than 20 or a turbidity less than 5 only one person in ten would object.

Careful inquiry among water-supply operators in close touch with consumers, and especially in cities of the size and importance of Hartford, failed to disclose what might be considered to be dissatisfaction or criticism if the color of the water supplied was 20 or less. On the other hand, those of the consultants who favored the rapid sand process of filtration were convinced that no water could be considered as satisfactory which had a color much exceeding 10.

As a result of the studies at Hartford it appeared that the majority of consumers would be content with a "polished" water the color of which ranged between 10 and 20, with an average most of the time about half way between.

To apply, then, the Whipple criteria to the water about to be supplied to Hartford: (1) There were no poisonous substances to be feared. (2) Either slow or rapid filters if properly operated would give freedom from organisms carrying disease. (3) Either slow or rapid filters properly operated would give a clear and clean water. (4) Either slow or rapid filters properly operated under Hartford conditions would give a clear and clean water. (5) Aëration (which is provided) would help in correcting odor difficulties and neither type seemed to take precedence in this matter.

In addition to the above: (1) From the evidence

and the arguments submitted and from a study of the results obtained elsewhere with both types of filters it seemed that at most after a short term of years either type of filter would supply an effluent which would be entirely satisfactory as to color; i.e., a water for domestic use with a color of from 11 to 13. (2) The slow sand filter appeared to be more "fool-proof" when operated by ordinary water-works labor, and for the major labor at the plant it is planned to draft men when needed from the permanent maintenance force of the department. (3) The character of the water is such that it is probable that with the rapid type several chemicals in combination would be required at certain periods and forever. (4) The turbidity in the applied water is practically negligible, the ordinary range being from 2 to 5 p.p.m., with a rare maximum of 5 or 6. (5) Due to the great elasticity of the reservoir system supplying the filters it is possible to derive considerable advantage by using or avoiding use of any one reservoir or by a combination of two or more to send raw water with a minimum of color to the filters and thus lighten the load on them. (6) It also appeared that the daily, monthly and seasonal variations from the average color are not more frequent or of longer duration with the slow than with the rapid type of filter.

The slow sand process seems to have some advantages over the rapid process: (1) The use of chemicals is not absolutely necessary in order to have a water of satisfactory color. (2) There is much less danger, with slow sand filtration, of conditions which may be deleterious to service pipes and to house plumbing. (3) There is no intricate mechanism to get out of order or to be replaced at considerable expense.

Such were some of the reasons for the choice of the slow sand type of filter for Hartford conditions, and it was fully realized at the time that Hartford conditions might be somewhat unique in favoring the use of this type here.

The Purification Works and accessories may be described under six heads, as follows:

1. The Gate House is located off the 48-in. concrete pressure conduit, in which are placed a number of gates in the main line and connections by means of which the supply of water to the filters is controlled.

2. The Aërator is a circular basin about 40 ft. in diameter into which the water falls after being exposed to the air in fountain-like jets.

3. Filter Beds—After aëration the water passes to eight ½-acre filter beds, grouped in sets of four, each group being controlled by apparatus in a single regulator house, the entire system being under main control at the administration house located at the head of the filter system. Here are located main gates on the influent and effluent pipes, together with the laboratories, superintendent's office, men's room, necessary and convenient toilet arrangements, the heating apparatus, wash-water pumps, switchboards and motors for the control of the electric power, and the other necessary equipment. The filter beds are of concrete groined-arch construction, with piers 13 ft. on centers, and there is about 2.5 ft. earth cover to guard against freezing. The beds have about a foot of gravel of proper sizes to support the sand, and 4 ft. of sand with an effective size of some 0.3 mm. and a uniformity coefficient of about 2. A depth of 4½ ft. of water will be carried over the sand.

4. The Clear Water Basin is rectangular in shape, about 1¼ acre in area. It has a maximum depth of 15 ft. and a capacity of about 6 m.g.—sufficient to compensate for hourly variations in draft and still maintain a reserve for fire protection. It is covered with groined arches of concrete.

5. The Hydro-Electric Plant will furnish electric current for all purposes required in lighting and operating the filter plant, besides lighting other buildings of the department and supplying some power for other department uses. The plant is located at the foot of one of the reservoirs which has been put out of service because of the new supply. Water is supplied from two former reservoirs of the old supply system and in case of need water also can be supplied from the conduit of the new supply. The whole plant is self-contained and so compactly arranged that in case of an emergency it can be fenced off and operated without recourse to outside help. In case of trouble that should put the power plant out of commission, emergency operation could be maintained for a long period by means of a portable steam plant and triplex pump.

6. Chlorine Plant—For use in case of the necessity of sending unfiltered water to the city a chlorine gas house has been provided in which is located both an automatic and a manually controlled apparatus so placed on the supply main that all water drawn for city use must pass by and if necessary may be sterilized.

Four buildings for housing all of the equipment are now being built of quarry faced trap rock from near-by sources.

The cost of the entire purification plant, from the raw-water inlet to the outlet of the clear-water basin, including all piping, power plant and engineering, was about $1,100,000, equivalent to $62,860 p.m.g.d. rated capacity, or about $6.65 per capita of population supplied.

Cost Comparisons with Cambridge Rapid Filters—The City of Cambridge, Mass., has recently installed a rapid sand plant which in many ways is comparable with the slow sand plant at Hartford, both as to purpose and aesthetic requirements. Each treats a New England surface water stored in reservoirs, with considerable opportunity for self-purification and color reduction. The rated capacity of the two plants is also nearly the same: Cambridge, 14 m.g. daily; Hartford, 17.5 m.g. daily. The contract cost of the Cambridge plant as given by Col. George A. Johnson, the consulting and supervising engineer (*Fire and Water Engineering*, May 10, 1922) was $723,900, equivalent to $51,000 p.m.g.d. rated capacity, or $6.60 per capita of population served. The work for the Cambridge plant was undertaken in June, 1921, when prices of labor and construction materials were at least 30 per cent less than they were in 1918 and 1919, when the larger contracts for the Hartford work were made. Allowing for this difference in price level, the cost of the Hartford plant would have been about $845,000, or $48,400 p.m.g.d. rated capacity, or $5.13 per capita of population served. On the basis of equal cost levels it would seem that with a water similar to that at Hartford, and with similar conditions of construction and size of plant, the first cost of plant is about the same for either the slow or the rapid type of filter.

All of the works outlined above were designed, and the work of construction supervised, by the Engineer-

ing Department of the Board of Water Commissioners of the City of Hartford. Too much credit cannot be given to the designing engineers for their whole-souled interest in the development of this work, which in some of its parts was without precedent, or to the hearty co-operation and attention to detail of the field supervisory and survey force. It was due to these conditions that the parts of the plant went together like clockwork and worked without a hitch when the plant was started.

For consultants, special details of the filter plant were passed on by Robert Spurr Weston; those of concrete design, by J. R. Worcester; and the studies leading up to the type of filter finally adopted, by the late Frederic P. Stearns.

The Sacramento Floating Type of Aerator Nozzle

Central Cone of Low-Head Aerator Floats on Issuing Water Film—Permits Passage of Trash and Gives Uniform Spray

By Harry N. Jenks

Formerly Special Assistant Engineer, Filtration Division, Sacramento, Cal.; now Assistant Engineer Sanitary District of Chicago

A LOW-HEAD aerator nozzle with a central floating cone has been invented for use in the new water purification plant at Sacramento, Cal. This new nozzle, the underlying principle of which was discovered accidentally while the engineers were experimenting with a double-spray nozzle, has the following striking advantages: (1) Simplicity of design; (2) exceptional trash-passing ability; (3) uniformly excellent spray at all discharges; (4) adaptability to different head-discharge requirements, particularly for low heads; (5) hydraulic characteristics readily modified, chiefly by altering the weight of the central floating cone.

Service Requirements and Design Conditions—The Sacramento River, from which Sacramento is now supplied with water, will also be the source for the new works (*Engineering News-Record*, Sept. 12, 1920, p. 446, Jan. 27 and June 2, 1921, p. 162 and p. 924, and May 11, 1922, p. 782). During the late summer and fall months of very dry years, the river water is infested with algae, resulting in the production of tastes and odors, excessive dissolved oxygen content and hydrogen-ion concentration. In the course of the design of the new treatment works, it was realized that effective aeration of the water prior to coagulation, sedimentation and filtration would be necessary, or at any rate highly advantageous. An incidental advantage is a possible appreciable lowering of the temperature of the water supply.

All of the water delivered to the treatment plant must be lifted from the river by low-head centrifugal pumps which must be definitely limited in head if high efficiency is to be maintained. From these pumps water will pass normally to a grit basin having a surface area of approximately 7,700 sq.ft. The conditions of design indicated that if aeration were to be practised the aerating devices should be installed above this basin, and the design should be such that the aerators could be placed in or out of service at will, as a whole or in groups. Each vertical foot of low-lift pumping head has been calculated to cost for power alone about $350 per annum with an average quantity pumped of 20 m.g.d. For other quantities the costs would be roughly proportional.

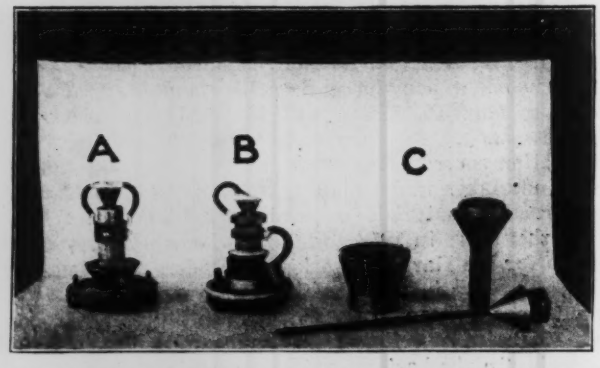


FIG. 1—NOZZLES EXPERIMENTED WITH AT SACRAMENTO FILTRATION PLANT

A: Original double-spray nozzle of fixed-opening type, cast in lead. B: Similar nozzle in brass, with supporting pin which cuts spray sheet. C: Simplified nozzle, with thin wedges at third points in the two annular openings. Dropping of wedges out of place led to their elimination and cones of perfect undivided spray self-adjusting.

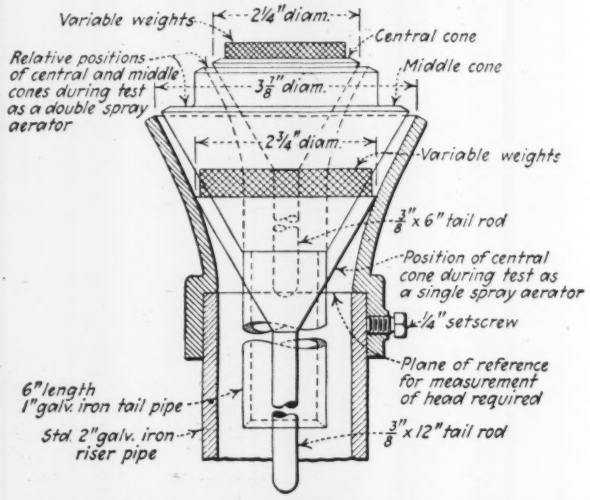

Variable weights
2¼"diam.
Central cone
Relative positions of central and middle cones during test as a double spray aerator
Middle cone
3⅜" diam.
2¾" diam.
Variable weights
⅜" x 6" tail rod
Position of central cone during test as a single spray aerator
¼" setscrew
Plane of reference for measurement of head required
6" length 1" galv. iron tail pipe
Std. 2" galv. iron riser pipe
⅜" x 12" tail rod

FIG. 2—SINGLE- AND DOUBLE-SPRAY NOZZLE ARRANGED WITH VARIABLE WEIGHTS FOR EXPERIMENTAL USES

After considering all available aerating methods it became evident that best results as to cost, efficiency and ease of manipulation, as a whole or in units, would be secured with aerators of the nozzle type. Because of the cost of head, it was decided to limit the total loss of head in the aerator system to a maximum of 5 ft. On account of the limited space which the aerator system would occupy, it was determined to place the pipe lines supplying the nozzles and on which the nozzles would be mounted on 4-ft. centers with the nozzles 4 ft. apart, thus allowing 16 sq.ft. to each nozzle, with the anticipation that the sprays would overlap and interfere somewhat. With 420 nozzles covering an area of 7,700 sq.ft. and delivering at the rate of 48 m.g.d., each nozzle would have to discharge 80 gal. per minute.

History of Development—Since no nozzles of which the engineers were aware would fully meet the head-quantity and other conditions set forth above, Prof. Charles Gilman Hyde, consulting engineer in charge of the pumping and filtration project, determined to design a nozzle that should have the required quantity-

head characteristics. The result is a nozzle that apparently operates on an entirely new principle and one which is applicable to the design of nozzles for aerating or distributing, or appreciably cooling, water and sewage.

[The nozzle has not been patented and the engineers are hereby making known the results of their studies and designs for the use of other engineers and to preclude others from patenting the nozzle.—*Editor.*]

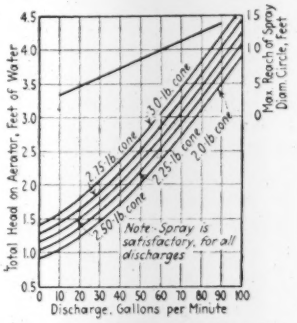
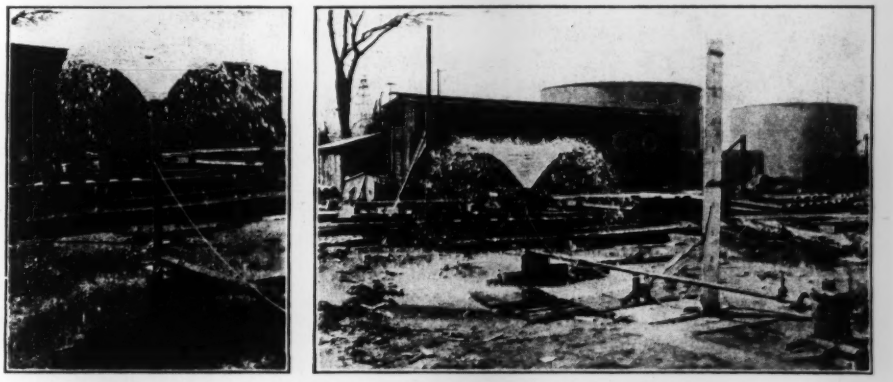

Total Head on Aerator, Feet of Water
Max. Reach of Spray Diam Circle, Feet
Discharge, Gallons per Minute
2.75 lb cone
2.50 lb cone
2.25 lb cone
2.0 lb cone
Note - Spray is satisfactory, for all discharges

FIG. 3 — HEAD - DISCHARGE CURVES FOR SINGLE-SPRAY TYPE OF AERATOR WITH FLOATING CONES OF VARIOUS WEIGHTS

The prescribed capacity, in conjunction with the low head allowed, indicated the advantage of using a double-spray nozzle. The original nozzle of the fixed-opening type, Fig. 1, *A*, which Professor Hyde cast in lead, gave such results as warranted the construction of a similar nozzle in brass, Fig. 1, *B*, turned on a lathe and made adjustable, so that any desired variation in thickness of both the upper and lower sprays could be had during the test.

A thorough test of this nozzle established the proper widths of openings to satisfy the quantity-head requirements and produce a spray that in the judgment of the observers would result in excellent aeration. In this connection the value of the hydrogen-ion concentration as a criterion in measuring the effectiveness of aeration was recognized. Comparison of the P_H content of the water supplied to the aerator and after it had passed through the nozzle, showed a satisfactory reduction in the P_H concentration resulting from the release of carbon dioxide. Such a reduction of the CO_2 content may be taken as indicative of the similar release of the excess dissolved oxygen and volatile oils which in the present instance is the primary object of aerating the water supply.

The nozzle just considered was, however, somewhat complicated, especially in its fin-like exterior supports. A third nozzle, Fig. 1, *C*, was accordingly turned out with a view to simplifying the casting by substituting for the exterior fins thin webs placed at the third-points in the two annular openings. In the experimental nozzle these webs took the form of thin, removable wedges set in shallow guide grooves in the cones for adjusting the width of opening as before. It was at once observed that the webs would be an objectionable feature because of the fact that they completely separated the spray into three parts which failed to reunite, thus rendering



FIGS. 4 AND 5—SINGLE-SPRAY FLOATING TYPE WITH 2.5-LB. CONE
The rate of nozzle discharge in Fig. 4 is 20 and Fig. 5 it is 80 gal. per minute

FIGS. 6 AND 7—DOUBLE-SPRAY FIXED-OPENING TYPE
Nozzle discharge in Fig. 6 is 20 and in Fig. 7 it is 80 gal. per minute.

ineffective a considerable area of the cones of spray.

While working with the higher heads, both the central and middle cones were lifted by the current off their supporting wedges, which then fell down the standpipe. Upon shutting off the water the two inner cones dropped back into the outer shell or base casting, closing both annular openings. Without attempting to replace the wedges the water was again turned on and it issued from the openings in smooth, unbroken cones of spray, even with the lowest discharges. This was in contrast to the fixed-opening nozzle which at very low heads, merely spilled water over the edges of the openings. It was noted that both the central and middle

cones had lifted slightly and were floating freely, supported by the thin membrane of water forming the cones of spray. As the heads were increased a point considerably below the delivery required was reached, at which the floating cones began to chatter. Aside from the chattering, the aerator as it then stood gave results fully the equal of any heretofore obtained, and superior at low delivery, as already noted.

Further experiments proved it was possible to stabilize the central cone by attaching a tailpiece in the form of a small iron rod, while the middle cone was likewise

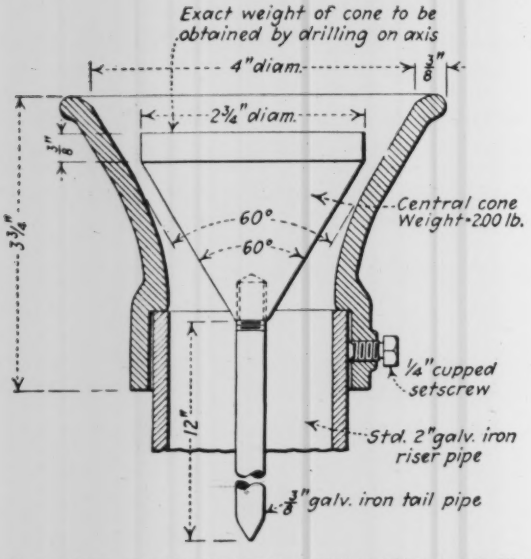


FIG. 8—THE "SACRAMENTO" SINGLE-SPRAY NOZZLE
Nozzle to be made of cast stove-iron. Weight of central cone includes tail rod.

stabilized by attaching a short length of 1-in. pipe which hung within the riser pipe and through which in turn passed the tail rod of the central cone (See Fig. 2). By these means a double spray, floating-type nozzle was evolved, superior in all respects to the former nozzles.

During the course of the tests observations were made on the general influence of the weights of the floating cones upon the head required. The investigation was continued to determine this effect quantitatively. To eliminate all the weight possible, the middle cone was removed and the nozzle was thereby reduced to a single-spray aerator. In respect to efficiency of aeration, fineness and distribution of spray the single-spray floating nozzle appeared to be fully the equal of the double-spray floating nozzle, while the head required by the former was considerably less. No chattering occurred and the spray was satisfactory at all heads. Experiments made to determine the optimum angle of the floating cone showed that a 60-deg. included angle gave the best results in conjunction with the size and shape of the base casting used in the tests, which had been designed for discharge at an angle of 60 deg. with the horizontal. Flatter cones of equal weight blew out even under low heads; steeper cones chattered under practically all heads.

Head-Discharge Curves for Floating-Type Nozzle—Final tests to determine the influence of varying weights of floating cone upon the head-discharge characteristics of the nozzle were made on an aerator comprising the base casting and 60-deg. floating cone with the 12x⅜-in. tail rod shown in Fig. 2. The discharge was measured by a 3-in. turbine-type water meter. Heads were read on a gauge board connected with a piezometer opening in the aerator riser pipe 12 in. below its top which was taken as a plane of reference. The head for each discharge rate recorded was referred to this datum plane by adding to each piezometer reading on the gage the corresponding velocity head and subtracting the corresponding friction head due to the 1-ft. length of riser pipe between the piezometer opening and the datum. The ordinates, therefore, of the curves in Fig. 3 represent the total pressure-plus-velocity head required to produce the discharges shown by the abscissae. In the upper part of the diagram a curve has been drawn to show the maximum diameter of circle over which the spray was distributed between the discharges of 10 to 90 gal. per minute. This maximum reach of spray was found to be practically proportional to the discharge regardless of the weight of the central cone.

The various nozzles in action are shown in Figs. 4 to 7.

In Fig. 8 is shown the final design for the Sacramento aerator nozzles. These nozzles are to be made of cast stove-iron because of the inexpensiveness of this material and the exceptionally smooth castings that result from its use. The nozzle consists of two extremely simple castings, the central one and the base casting or outer shell. The latter will fit over the 2-in. riser pipe and be held firmly in place by a ¼-in. cupped set-screw. The outside of the riser at the top will be smeared with bitumen or white lead to insure watertightness at the base of the nozzle. The tail rod will be screwed into the central cone, thus providing for ready replacement or substitution by a rod of a different length.

The experiments leading to the development of the "Sacramento" floating-type aerator nozzle were made by the writer in co-operation with C. G. Gillespie, resident engineer, and Prof. Charles Gilman Hyde, chief consulting engineer, whose original nozzle design furnished the basis for the present investigation.

Palestine Has Efficient Railway System

Communications have been so greatly improved within the past year that today Palestine enjoys probably the best railway service in the Near East.

An efficient railway system in Palestine is a heritage of the war. In their military operations the British built the line from Kantara on the Suez Canal to a point near Gaza, connecting there with the old pre-war narrow-gage system. The gage was broadened and an extension built into Haifa. The system, now 500 kilometers in length, connects with the Egyptian State railways at Kantara and with the Syrian railways in the north.

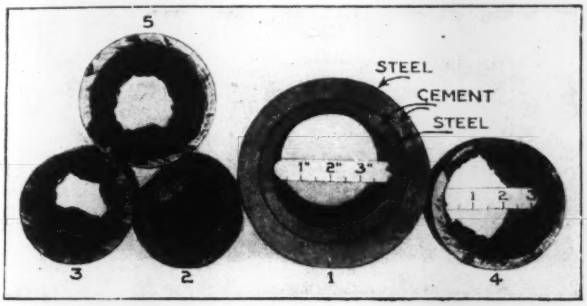
The motive power and rolling stock is in first-class condition. American locomotives built in 1918 for the British War Department are used, having evidently been turned over to the Palestine railways. A few mountain saddle-tank type locomotives built in Leeds, England, have been added recently. A number of new passenger coaches from England, together with international sleeping cars afford good accommodations to travelers. Daily passenger and mail service are proving beneficial to business.—*Commerce Reports.*

Cement-Lined Cast-Iron Pipe at Charleston, S. C.

Tuberculation of Tar-Coated Cast-Iron Pipe at Charleston and Elsewhere—70 Years' Experience With Cement-Lined Sheet Pipe in Many Cities Suggests Cement Lining for Cast Iron—Lining Method

By J. E. Gibson
Manager and Engineer Water Department, Charleston, S. C.

THE Water Department of Charleston, S. C., is now laying some ten miles of 4- to 24-in. cement-lined cast-iron pipe. Of this, 7 miles is 6- and 8-in., 2½ miles is 16-in., and the remainder is 4-, 12- and 24-in. pipe. After reviewing the reasons for adopting cement as a substitute for the ordinary tar coating, this article will describe the cement-lining process and related matters. The review just mentioned will include an account of the decline in carrying capacity of cast-iron pipe at Charleston and the quick recurrence of this decline after cleaning the pipe; the character of the Charleston water; a few of many possible instances of tuberculation or incrustation of cast-iron pipe elsewhere; and a



CEMENT-LINED SHEET AND STANDARD CAST-IRON PIPE AFTER 22 YEARS' SERVICE
No. 1, cement-lined, Nos. 2-5, cast-iron. All 4-in.

resumé of the use of cement-lined wrought-iron or steel pipe in a considerable portion of the United States during the past seventy years. These experiences, many of them under my direct observation, and all satisfactory as regards the prevention of the loss of carrying capacity through tuberculation or incrustation of the pipe, have seemed to give full warrant for the extensive trial of cement lining for cast-iron pipe now being made at Charleston.

Loss of Capacity in Tar-Coated Cast-Iron Pipe—Water-works engineers and superintendents have long realized that the carrying capacity of cast-iron pipe protected with the so-called tar coating begins to fall off in some cases soon after the pipe is put in service. Recognition of this condition is found in nearly all hydraulic tables, constants being given for pipe of different ages. This allowance for age is proper, but the constants are only approximately correct for general use.

Those living along the Atlantic and Gulf seaboard from Maine to Mexico are familiar with the highly colored peaty waters of that section, and it is this class of water that seems to cause the greatest trouble from tuberculation or incrustation. At least that has been my observation. As to why this should be so, I can only suggest that usually this water is very soft, being either swamp water or else water naturally stored in a freestone formation and in either case normally low in alkalinity. It carries comparatively large amounts of vegetable acids, leached from the leaves and roots of the trees growing on the drainage area. These waters are alkaline to methyl-orange or erythrosine, but acid to hydrogen-ion tests.

Charleston Conditions and Experience—Including the Capacity Loss in Standard-Lined Cast-Iron Pipe—Charleston is located on a peninsula formed by the junction of the Ashley and Cooper Rivers. The average elevation of the city is probably not over 10 ft. above mean high tide. The soil is composed of an alluvial sand and blue clay shell deposits, highly charged with organic and saline matter that rapidly corrodes wrought-iron and steel pipe.

The water supply of Charleston is obtained from Goose Creek, an estuary of the Cooper River, the water being pumped through some 60,000 ft. of 24-in. cast-iron main laid in 1903. This main was well laid and for a number of years little trouble was experienced in maintaining ample pressure in the city. However, as the city's demand increased, the water company had difficulty in maintaining a satisfactory pressure, although the economical capacity of the main was not exceeded. Upon investigation it was found that the friction loss per 1,000 ft. of main was about double that given in the recognized hydraulic tables, even when an allowance for the age of the pipe was made.

After a thorough investigation of its condition the main was cleaned in February, 1915, with the result that the friction loss was reduced to approximately that of new pipe; but in about three months the friction loss had increased practically to that previous to cleaning. The main was then cleaned a second time, in April, 1916, with the same result recurring.

In 1917 Charleston bought the plant from the Charleston Light & Water Co., and I was placed in charge as manager and engineer. As a first step in an effort to improve the pressure and service, it was decided to clean some of the mains in the downtown or older section of the city. Tests were made before and after cleaning to determine the friction losses per 1,000 ft. of main. The average result observed on a 6-in. main laid in 1886 gave a value of the coefficient "C" in Chezy's formula ($V = C\sqrt{RS}$) of 34 before and of 90 immediately after cleaning. Tests fourteen months later showed a fall of "C" to an average of 61.

Cast-Iron Main Again Cleaned—The demand for water, incident to the war activities, being greatly reduced after the armistice was signed, more time became available after 1919 for improving the general service and effecting economies in operation. The friction loss in our 24-in. main necessitated too high a pressure at the pumping station in order to provide satisfactory pressure in the city and it was decided to clean it. Before cleaning the friction loss was 4 ft. per 1,000 ft. when pumping at the rate of 6.5 m.g.d. and the value of "C" was 72, against a theoretical friction loss of about 1.6 ft. per 1,000, using Weston's or Williams and Hazen's tables, coefficient 120.

Tests made immediately after cleaning the main in April, 1921, showed a value of "C" (Chezy) of 106.5. Tests made thirty days later gave "C" as 90; or the effect of cleaning had been practically lost within thirty days. Needless to say, this was a great surprise to us, and we at once began to study means for improving conditions, especially for new mains. Our experience in Charleston has been that the loss in the carrying capacity of standard-lined cast-iron pipe is approximately 20 per cent within three years, and that the results of cleaning do not last more than four or five months at best.

Cement-Lined Wrought-Iron or Steel Pipe—Comparisons with Cast-Iron Pipe—From 1897 to 1917 I was principal assistant engineer to J. W. Ledoux, then chief engineer of the American Pipe & Construction Co., Philadelphia, and while so engaged became thoroughly familiar with the use of cement-lined wrought-iron or steel pipe. The company named laid hundreds of miles of this pipe under the Phipp's patents. I had occasion to remove and examine sections of pipe in use as long as 20 to 25 years and cannot recall ever having seen a piece of cement-lined pipe that had tuberculated or incrusted. Tests made by us on cast-iron and on cement-lined pipe laid from 20 to 30 years never showed any loss of carrying capacity of cement-lined pipe, but in all cases which came to my attention there was a loss with the ordinary cast-iron pipe.

A test of a 4-in. cast-iron main at Mount Vernon, N. Y., that had been in use for about 25 years, gave a value of "C" of only 25 before and 107 after cleaning. A 6-in. main in the same city gave a value of "C" of only 29 before and 125 after cleaning. A piece of 4-in. cement-lined wrought-iron pipe removed from the mains of the Springfield Consolidated Water Co., Ridley Park, Pa., laid in 1889, showed no internal deterioration of incrustation whatever, but a piece of 4-in. cast-iron pipe laid in the same system and about the same time in the Landsdowns, Pa., distribution system, was very badly tuberculated.

Mr. Haydock, engineer of the Mountain Water Supply Co., of Philadelphia, reports that cast-iron pipe in many parts of their system lost more than 20 per cent of its carrying capacity in the first ten years it was in use, due to tuberculation. All their water is very soft and low in solids.

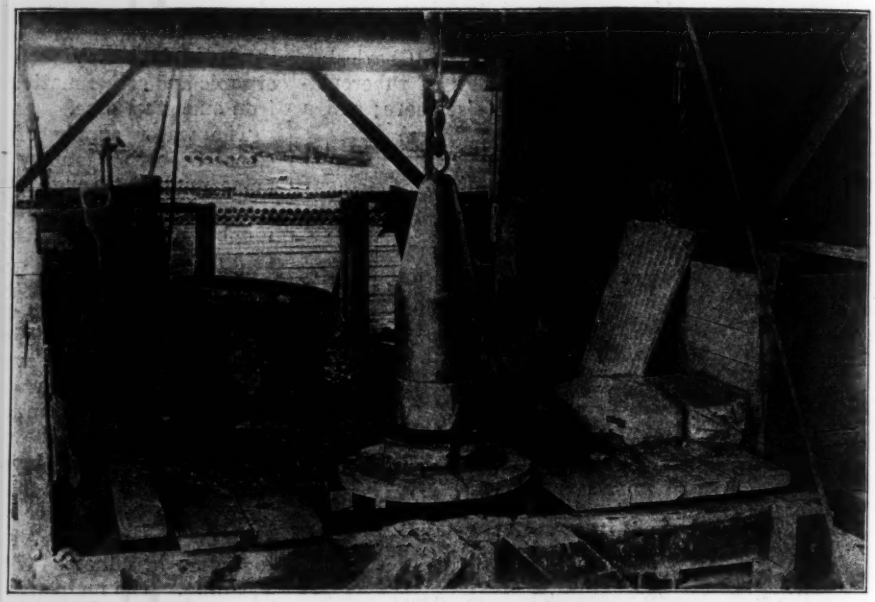
Experience of the Two Normans—Bradford Norman, president of the Newport (R. I.) Water-Works Co., in a recent letter writes:

Cement-lined pipe was furnished George H. Norman by the Jersey City or New Jersey Patent Water & Gas Pipe Co., during the period from about 1865 to 1877, after which Mr. Norman began to make it for the work he was then doing, as the patent right had expired. Cement-lined pipe was in use in New York State earlier than on Mr. Norman's work. [George H. Norman, father of Bradford Norman, was admitted to the American Society of Civil Engineers as member in 1869, and died in 1900. He built many water-works in New England, using cement-lined pipe.—EDITOR.] There were other concerns making pipe during the period between 1865 and 1875: one Dr. Phipps, somewhere in Connecticut, I think Bridgeport, and also a firm called Goodhue & Birney [of Springfield, Mass.—EDITOR].

In regard to the fouling of cement-lined wrought-iron pipe, I have yet to see any tuberculation or incrustation of any part that had a coating of cement. The cast-iron gates, branches, etc., were the only parts that ever showed any signs of tuberculation or incrustation. (These cast-iron parts were not coated with cement.)

Newport has in its distribution system 88 miles of cement-lined pipe from 20- to 4-in. in size.

Plymouth, Mass., Still Makes Own Cement-Lined Pipe—A. E. Blackmer, superintendent of the Plymouth Water Works, Plymouth, Mass., writes:



PLANT FOR LINING CAST-IRON PIPE WITH CEMENT

Lining cone being lowered into pipe. Neat natural cement is poured into space between cone and shell of pipe and the cone is then lifted, forming a lining to the pipe.

We have now about 57 miles of 4- to 18-in. pipe in our system, all cement-lined. I estimate that about 65 per cent of this mileage is of the Phipps type and the balance is the old style. Our experience with this pipe has been very satisfactory. During the past season we made and laid about 2,000 ft. of 10-in. pipe to replace the same amount of 8-in. old style pipe that had been in continuous service since 1855. [See *Engineering News*, 1916, II., p. 300, for description of making and laying cement-lined sheet-steel pipe at Plymouth.—EDITOR.]

The Pennsylvania Pipe Co., of Philadelphia (now the American Pipe & Construction Co.), bought the patent rights of Dr. D. Goffe Phipps (engineer of the Bridgeport, Conn., Hydraulic Co.) for the United States, with the exception of New England, and continued the manufacture of this pipe, with certain improvements, up to about 1917. The company built many water-works throughout the Eastern United States and undoubtedly laid upwards of a thousand miles of this type of pipe. One of the earliest of these works was that of the Westmoreland Water Co., Greensburg, Pa., constructed in 1889. Shortly before his death five or six years ago,

Murray Forbes, then president of the Westmoreland Water Co., stated that the pipe was then in good condition and with the exception of some trouble which was experienced with the joints he had no complaint to make whatever.

The American Pipe & Construction Co. built the works of the Paris Mountain Water Co., Greenville, S. C., in 1890. A piece of cement-lined pipe taken out of the 12-in. gravity supply main of these works at the time of the construction of Camp Sevier showed that the interior surface was in perfect condition.

The water-works of Waukesha, Wis., constructed about 1887, used pipe manufactured under the method used by George H. Norman, above referred to. I personally removed sections of this pipe at the time of its valuation for purchase by the city about 1905 and found that its interior surface was in perfect condition and that there was no deterioration of the metal where the exterior coating was intact, although this pipe was made of one part Louisville cement and three parts sand. The better practice (followed by the American Pipe & Construction Co. and by the early cement-lined wrought-pipe manufacturers generally) was to use a mortar of neat cement—and that is what is being used to line cast-iron pipe for Charleston.

One Company Has 500 Miles of Cement-Lined Sheet Pipe—The Springfield Consolidated Water Co. which supplies the suburbs of Philadelphia, has in use upwards of 500 miles of 4- to 16-in. cement-lined wrought-iron pipe and is satisfied with its service. The company has no records of tuberculation or falling off in capacity.

Observation made on a piece of cement-lined pipe removed from Danvers, Mass., after 39 years' service, shows that the bore is much smoother than that of new pipe. This condition agrees with my own observation of pipe removed at other points; therefore, it is reasonable to conclude that the coefficient of cement-lined pipe will improve rather than deteriorate with age.

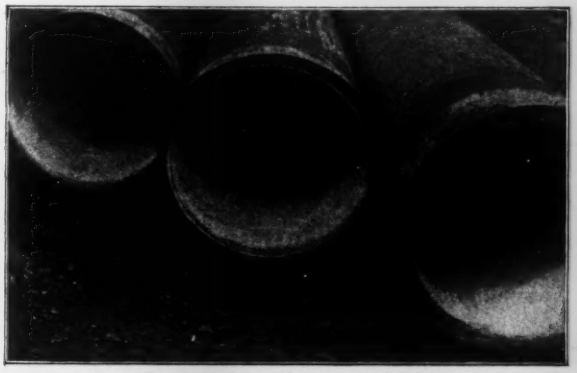
Besides the cities and companies already mentioned the following have a portion of their distribution systems or supply mains of cement-lined wrought-iron pipe: Moorestown (N. J.) Water Co.; Monmouth County Water Co. Asbury Park, N. J.; Riverton (N. J.) & Palmyra Water Co.; Westfield (N. J.) & Newbold Water Co.; Wildwood (N. J.) Water Co.; Norfolk (Va.) County Water Co.; Sumter (S. C.) Water Co.; Milledgeville (Ga.) Municipal Works; Tallahassee (Fla.) Water Co. So far as I have been able to learn, no one has seen a case of tuberculation or interior incrustation of cement-lined pipe.

In passing, it may be stated that in my opinion any difficulties experienced with cement-lined wrought-iron or steel pipe have been due to making joints and taps. I believe there are no joint difficulties where bell-and-spigot joints—the more recent practice—have been used, but the tapping difficulty still exists. It may be added that service taps are made by bolting a "hat" flange onto the pipe or by building one into the cement wall when the pipe is being made.

Charleston Adopts Cement-Lined Cast-Iron Pipe—The foregoing data seemed to warrant the adoption of cement-lined pipe by Charleston. In 1921, the question of furnishing some 30,000 ft. of 24- and 12,000 ft. of 12-in. cement-lined pipe was taken up with manufacturers. It was finally decided that on account of the corrosive quality of the Charleston soil, already mentioned, there was too much danger that the exterior portion of the cement in either cement-lined steel or in steel-reinforced cement pipe might be injured in such a way as to expose the steel and finally destroy the pipe. This was considered to be so serious a matter that it was decided to take up the question of obtaining cement-lined cast-iron pipe, thus using a material that had withstood the test of time so far as exterior deterioration and corrosion were concerned. Cast-iron pipe is known to have withstood soil corrosion for a hundred years or more.

In place of the eight miles of 24- and 12-in. pipe first proposed we are putting down ten miles of 24- to 4-in. pipe (mostly 6- and 8-in.), as stated near the beginning of this article.

It was first thought advisable to make a special size pipe so that when the lining was in position the nominal diameter would agree with the actual diameter, but as this entailed the manufacture of new flasks and patterns, special size valves and fittings, we decided to line only pipe made of standard pattern. The only difference is that we did not coat the pipe with the customary tar preparation.



VIEW OF 16-IN. CEMENT-LINED CAST-IRON PIPE

While the cement lining slightly reduces the area of the pipe, the increased capacity due to the better surface and higher coefficient in a great measure offsets the reduction in cross-sectional area and the reduction is entirely offset where cast iron is subject to tuberculation. The thickness of cement linings are $\frac{5}{16}$ in. for pipe with nominal diameters of 4 to 10 in., and $\frac{1}{2}$ in. for diameters of from 12 to 24 in.

Manufacture—The method being used in lining cast-iron pipe with cement is the same as that employed in putting a similar lining in wrought-iron pipe. The cast-iron pipe is placed on end, after which a "bullet" or lining cone is lowered into the barrel to the bottom. The machine that up-ends the pipe automatically centers the lower or bell end of the pipe, and the upper end is similarly centered at the time of lowering the lining cone. The requisite quantity of neat *natural* cement, previously mixed by a special machine, is then poured into the upper end of the pipe, after which the bullet is immediately pulled up through the barrel of the pipe spreading the cement the same as a plasterer would spread a coat of plaster on a wall. The principal consideration in getting a good lining is to have the mortar of the proper consistency and at the proper point of setting, so that when the lining cone is pulled upward through the pipe the mortar will not slough down or, conversely, will not be pulled up through the pipe with the lining cone, due to its having set too hard.

Several different grades of cement were experimented

with, but in the end we returned to natural cement, as it has a quicker setting time and does not check or shrink as much as Portland cement.

Field-Work—The cement-lined cast-iron pipe is cut or tapped in the same manner as standard coated cast-iron pipe. When the point of the drill passes through the shell of the cast-iron pipe and enters the cement, the cement lining spalls off at an angle of about 45 deg., leaving a thin protection coating of cement at the edge of the drill hole.

In laying pipe the foreman must carefully inspect the spigot ends for splits and cracks, for no dependence can be placed on sounding the pipe, as in the case of unlined pipe, for the cement lining effectually destroys its resonance.

In cutting cement-lined pipe the same procedure is used as in unlined pipe. If reasonable care is taken no difficulty will be experienced with the cracking out of the thin cement lining. Should this occur, however, the damage can be easily repaired by patching with a little neat natural cement of the same brand as that used in lining.

The pipe joints are made in the usual way, with lead and jute or other customary joint materials, which materials do not come into contact with the cement lining.

I feel that in the combination of cast-iron with cement we have a product that is a decided step in advance for the Charleston water distribution systems and a combination of materials that will endure indefinitely.

All of the pipe being furnished the Charleston Water Department is being manufactured by the American Cast Iron Pipe Co., Birmingham, Ala., which has co-operated with the department in this new departure in the water-works pipe field.

Pollution of Coast Waters and Beaches With Oil and Tar

BY C. M. SAVILLE
Member Connecticut Stream Pollution Commission, Hartford, Conn.

ELIMINATION of oil and tar pollution from beaches and coast waters was the subject of a conference at Atlantic City, N. J., Aug. 10 and 11, attended by representatives of a number of seaboard states and cities and of other interests. This form of pollution is a growing menace to seaside resorts and fishing and boating interests along miles of coast. It is said to have cut the former large fish yield along the northern New Jersey coast to a few barrels. Waters are made offensive to bathers and boatmen, boats damaged, beaches polluted, fish and shellfish killed and water fowl seriously injured.

The pollution comes from the discharge by tankers and oil-burning craft of oil and tar wastes and oily bilge water and ballast just before making port and from the wastes of oil refineries, gas works and asphalt plants located on tidewater.

Federal control seems necessary if this nuisance is to be stopped. Existing laws would give at least some relief if only there were funds for their enforcement. It has been suggested that clearances should be denied to all tankers and oil-burning craft unless they can prove to the satisfaction of the authorities that their process of cleaning out oil residue, other oil wastes and water ballast, while in port is so conducted as not to cause detriment to the waters. Two preventive measures that have been found to be more or less efficacious are: (1) Discharging the wastes into suitable vessels alongside in the harbor and carrying the wastes to suitable reservoirs where the oil would be recovered by separation from the water and made useful for several purposes, such as for fuel when mixed with powdered coal, or for road work after proper preparation; (2) separators on the vessels themselves. It is said that abroad oil wastes are not permitted to be discharged where they will cause damage; also that in England and Holland the first method named is in use and that Japanese vessels are equipped with apparatus for the second.

Several bills designed to eliminate the oil pollution evil are now before Congress. The one proposed by Hon. T. Frank Appleby (H.R. 10,956, 67th Congress 2nd Session) seems to contain the best provisions and to offer the most satisfactory means of preventing continuance of the polluting causes. This bill was endorsed by the convention, many hitherto objectionable features relating to inland waters in the first draft having been eliminated. Besides this, a petition endorsed by the President of the United States has been presented to the Senate and to Congress by the officers and members of the "Interstate Committee of One Hundred on Pollution of Coast Waters and Beaches" representing various municipalities and coast resorts of New York and New Jersey calling attention to the urgency of the matter and praying for adequate federal aid to enforce the present laws.

Among the officers elected by the Atlantic City conference were: President, Gifford Pinchot, of Pennsylvania; secretary, Sidney H. Phinney, Trenton, N. J.; an executive committee of nine members, including S. DeM. Gage, chemist and sanitary engineer, Rhode Island State Board of Health, Providence; and the writer.

Light-Colored Joint Filler Developed for Concrete Roads

A cement-colored filler has been developed in the laboratories of the U. S. Bureau of Public Roads for filling cracks and joints in concrete pavements to eliminate the unsightly appearance of the black lines resulting from the use of the bituminous fillers commonly employed. No particular advantage over other good materials is claimed for the preparation other than its color and it is probable that the cost will be somewhat higher but not prohibitive. For several weeks a section of road with expansion joints of this material has been under observation and the results are entirely satisfactory but a longer test will be necessary before it can be recommended for general use.

The mixture consists of approximately 12 parts rosin, 1 part crude rubber with sufficient barium sulphate to give the desired color. In preparation the rubber is dissolved in gasoline and the rosin is then mixed in with an application of heat, the coloring material being added as required. Any desired consistency can be obtained by varying the proportions. A material with remarkable adhesive properties is produced and which can be heated so that it will flow into the cracks and joints.

Prechlorination-Alum Treatment of Soft, Colored Waters

Experiments and Seven Years' Working Results Show Low Colored Mechanical-Filter Effluent Nearly Non-Corrosive

By Arthur L. Gammage

Chief Chemist, Weston & Sampson, Consulting Engineers, Boston, Mass.

WATER purification has reached a state where soft, colored waters may have the color and suspended dirt removed economically and the water made nearly non-corrosive. Sanitary engineers have agreed that the soft, colored waters of the coastal region, both East and West, are difficult to purify by methods which have been effective in improving the harder waters of the Middle Atlantic States and the waters of the Great Lakes section, and that these soft, colored waters may be corrosive to pipes after filtration.

TABLE I. EXPERIMENTS MADE ON RAW WATER FROM PLANT

Alum and soda used given in parts per million

	Run of Plant, Dec. 2			Run of Plant, Dec. 4			
	Raw Water	Alum 29.2 Soda 13.2	Alum 29.2 Soda 10.4	Raw Water	Alum 31.9 Soda 9.8	Alum 29.2 Soda 8.4	Alum 29.2 Soda 6.0
Color	50	15	8	50	8	6	5
Turbidity	10	1	1	10	0	0	1
Alkalinity	3.5	5.9	3.8	2.8	3.2	3.2	3.4
Carbon dioxide	1.9	8.1	9.8	1.7	10.3	10.6	9.8

Whether these waters should be purified by slow sand filters alone, or mechanical filters preceded by alum coagulation, or chlorine alone or some combination of these methods should depend on the average and variable quality of the water to be treated and the final water desired by the consumers.

Measured by work done in relation to cost of doing it, the slow sand filter is very inefficient when used to remove bacteria, color or suspended matter. For work done at low cost in safeguarding a water supply, chlorine leads. Chlorine alone cannot remove much turbidity or color. But there is a way that chlorine can assist filter alum in coagulation and color removal which has been very little appreciated and very little used. It is the use of chlorination and alum coagulation preceding mechanical filtration.

Experiments at Belfast, Me.—In early December, 1914, the writer made an inspection of the water purification plant of the Belfast Water Co. (described by Robert Spurr Weston in *Engineering News*, July 23, 1914, p. 180). As the water was very cold and the color removal appeared poor for the amount of chemicals added, only a few experiments were made. The methods which will be described have been used at Belfast, Me., and Exeter, N. H., and at Acadia Mills, Lawrence, Mass., for over seven years. It is well known that cold temperature retards chemical action. These experiments were made as a result of observations on cotton and woolen mill use of caustic soda, soda ash, lime, sulphuric acid, and bleach to remove dirt and coloring matter from the materials in the process of manufacture. They were made entirely at the writer's suggestion for the Belfast Water Co., whose plant was later sold to the Belfast Water District, which has given permission for the publication of the data.

Run-of-Plant Experiments—The first experiments were made in the ordinary plant run where we were feeding filter alum to coagulate the color and soda ash to supply alkalinity for coagulating the alum. Several experiments on decreasing the soda ash were made and, as expected, decreased color resulted, with decreased alkalinity and increased carbonic acid. (See Table I.)

Bottle Experiments—Two bottle experiments were made, using raw water from the pond like that shown by the analysis in Table I. (1) Alum, 2 grains per gallon, soda ½ grain per gallon, bleach 2 p.p.m. or 0.66 p.p.m. available chlorine, gave color, 1; turbidity, 00; alkalinity, 1; carbon dioxide, 16.8 on 24 hours' reaction (2) Alum, 1½ grains per gallon, soda 1½ grains per gallon, gave color, 30; alkalinity, 9.9 p.p.m.; turbidity, 1; carbon dioxide, 6.3 p.p.m.

Further Plant Experiments—The raw water from the pond on another date showed color, 50; alkalinity, 2.8 p.p.m.; turbidity, 10; carbonic acid, 1.7 p.p.m. Three tests at the filter plant with different rates of treatment were made. (1) 31.9 p.p.m. alum and 9.8 p.p.m. soda gave (after filtration) color, 8; alkalinity, 3.2 p.p.m.; turbidity, 0; carbon dioxide, 10.3 p.p.m. One grain per gallon of soda added to the filtered water made the color 12. (2) 29.2 p.p.m. alum and 8.4 p.p.m. soda gave a filtered water of color, 6; alkalinity, 3.2 p.p.m.; turbidity, 0; carbon dioxide, 10.6 p.p.m. (3) 29.2 p.p.m. alum and 6 p.p.m. soda gave filtered water of color, 5; alkalinity, 3 p.p.m.; turbidity, 1; carbon dioxide, 9.8 p.p.m. There is close agreement between the bottle experiments with four hours' coagulation and the plant tests with 1¾ grains of alum and four hours in the coagulating basin.

Effect of Additional Soda—Using the same raw water as noted in the preceding paragraph, bottle experiments with four hours' coagulation were made to show the effect of additional soda on color, alkalinity and carbon dioxide. Samples thus treated and then filtered gave the results shown by Table II.

TABLE II. EFFECT OF ADDITIONAL SODA ASH ON COAGULATED WATER

Soda Ash Grains per Gal.	Color	Alkalinity P.P.M.	Turbidity	Carbon Dioxide P.P.M.
0	5	0.6	1	15.1
0.25	5	0.7	1	13.5
0.50	5	0.7	0	11.6
0.75	7	0.8	1	9.3
1.00	12	4.5	1	7.6
1.50	14	8.5	1	6.1

The experiment was tried of increasing the soda alone, and with increasing amounts of bleach. Table III shows the increase in color due to additional soda, overcome by additional bleach, also the reduction in carbon dioxide caused by bleach, and increase in alkalinity. None of these samples showed additional precipitation with soda, and no additional precipitation on standing alone.

Up to the limit to which it can be used without causing taste, bleach with filter alum has been found to be more efficient than filter alum alone, in reducing color and assisting the coagulation as well as in destroying organic matter and assisting to keep the filter sand in good condition.

It was believed that at Belfast, 2 p.p.m. bleach (0.66 p.p.m. available chlorine) would give a lower color to the water with a given alum treatment, reduce the iron in the filtered water and keep the filters and coagulation basin cleaner of organic matter which undergoes some decomposition wherever found. Plant experi-

TABLE III. EXPERIMENTS ON INCREASING SODA ALONE, AND WITH INCREASING RATES OF BLEACH

Alum Grains per Gal.	Soda Ash Grains per Gal.	Bleach P.P.M.	Available Chlorine	Color	Turbidity	Alkalinity P.P.M.	Carbon Dioxide P.P.M.
1½	½			8	1	1.5	10 1
1½	1			10	1	1.8	9 9
1½	1½			15	2	2.2	9 8
1½	½	1 0	0 33	6	1	1.5	9 9
1½	1	2 0	0 66	4	0	1.8	9 1
1½	1½	3 0	1 00	2	0	2.4	8 4

ments confirmed these results, and there was no free chlorine in the filtered water.

These experiments show that on this water decreased alkalinity and increased carbonic acid give better color removal; also that chlorine can improve the color removal and overcome the effect of increasing alkali in the water naturally or added artificially. It is the writer's opinion that it does this by chlorination of certain compounds and by hydrolysis of certain other compounds. Besides making the whole reaction more one in which color and alum hydrate and organic colloids precipitate rather than dissolve.

The reservoir from which this water was drawn had been deforested shortly before the purification plant was built. The water therefrom contained a large amount of new coloring matter which was difficult to remove. A portion of this coloring matter, judging from its action with chlorine, appeared to be electropositive, but when the alkalinity of the water was low and the carbonic acid high, or when chlorine was used, even less than any excess, the color removal was excellent, and no uncoagulated alum sulphate or colloidal alum hydrate went through the filters when running these experiments.

The chlorine or bleach can form saturated compounds of the tannates of almost all classes, and the alum treatment can remove these. The chlorine can accomplish several other chemical reactions, some of which are too complicated for many water experts to understand without further study. Chlorine in water can be made to work rapidly or slowly, depending on how it is introduced into the water. Overcoming the effect of soda with chlorine produces an apparent lowering of OH ions in alum coagulation without a reduction actually taking place, thus increasing the efficiency of alum treatment, or saving alum.

At Belfast, bleach was used with alum and worked rapidly on the water, like free chlorine, because of the interaction of these chemicals. Gravimetric tests showed that all the alum added to the water at Belfast was removed by filtration, and sometimes some alum was removed which was naturally present in the water.

There is not much doubt among chemists but what lowering the alkalinity and increasing the carbonic acid will increase the corrosiveness or aggressive action of the water on metals, such as filter underdrains of metal or metal supply pipes, but the filter underdrains at Belfast are of concrete.

The use of chlorine will increase the corrosiveness of the water still more, but all the free chlorine can be used up in the filtering system and much of it removed by the coagulation and filtration. The floc formation is more satisfactory by forming smaller clear-cut (not milky) coagulation, and the floc subsides more quickly and the water filters more rapidly, besides which the filter sand is kept cleaner of accumulations of organic matter which in many cases form mud balls in the sand.

In these experiments, the alkalinity tests were made with erythrosine in accordance with the Standard Methods of Water Analysis of the American Public Health Association, and the carbonic acid tests were made according to the same standard methods. The alkalinity, when low, tested by erythrosine gives slightly higher results, usually about 2 p.p.m., as carbonate of lime ($CaCO_3$), than the methyl red indicator, which has a P_H range of 4.4 to 6 acid red to alkaline yellow. This ties up the alkalinity results on this water to the H-ion determination, and the P_H is very low, much less than 7. The corrosiveness of the water is tied up to the H-ion determination, using phenolphthalein as indicator, and numerous experiments have shown that if the water is neutral to phenolphthalein with low alkainity it is about as non-corrosive as it can be made practically, and will likely have a P_H near 7; but if the alkalinity is higher say 40 to 60 p.p.m., it might have P_H7 and still be corrosive, due to excess carbonic acid.

If the filtered waters resulting from the above treatments are too corrosive for the distribution system used, they may be corrected by lime or soda ash, or even caustic soda in certain cases, after filtration, and the color increase will be much less than if an attempt was made to remove color, produce good coagulation and rapid filtration by the best floc and correct the corrosiveness, all in the coagulating basin. Aeration after filtration will reduce carbonic acid and lessen the alkali necessary for neutralizing carbonic acid.

The carbon dioxide test, as made on these waters, is really the resultant of CO_2 or H-ions free to act, and probably depends partly on the half-bound carbon dioxide when it is so low as well as the free carbon dioxide, just as the alkalinity result is probably a resultant of the free carbon dioxide (CO_2) acting against the alkaline bicarbonate to form a resultant alkalinity which is likely lower than it would be if there were no CO_2 present.

In this water, as in many such soft waters, the color is double at certain times what it is at others. In these plants the operators had to be taught to increase and decrease the filter alum and bleach with changes in color and add enough soda ash to have always some residual alkalinity after treatment. In one plant even caustic soda was used to reduce corrosiveness.

Other places may have waters of more or less color, more or less variation in the amount and kind of color, and may have suspended matter and variable alkalinity as well as variable corrosiveness. However, it is the writer's opinion that with a plant carefully designed for the water to be treated and with careful supervision, the water will have the degree of safety and good appearance which the public should demand.

Conclusion—Low alkalinity and comparatively high carbon dioxide give better color removal than simply a final alkalinity of 10 parts or more per million as generally used on coagulated waters. Prechlorination lowers the color with the same amount of alum, or by inference saves alum to obtain the same resulting color. Chlorine used with alum gives the effect of better color removal with higher alkalinity and lower carbon dioxide. Soft corrosive waters may be treated with lime or soda after mechanical filtration rather than with coagulation in the treating basins before filtration to secure much better removal of color and equal removal of carbon dioxide to obtain the lowest practical corrosive action with the purified water.

Laying 30-in. Submerged Pipe for Norfolk Water-Works

Integral Flexible-Joint Cast-Iron Pipe Laid From Cradle Suspended Between Two Barges—Bells Heated, Pipe Length Lifted to Cradle, Bells Reheated, Joints Poured From Special Pot, Rig Moved Forward

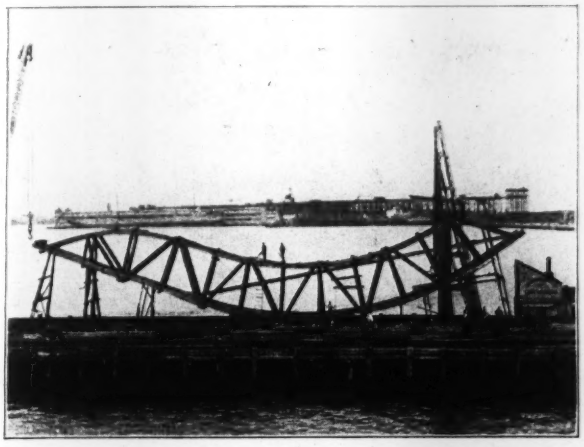
By David A. Decker
Principal Assistant Engineer, Department of Public Works, Norfolk, Va.

AND

John O. Miller
Resident Engineer, Department of Public Works, Norfolk, Va.

FLEXIBLE-JOINT cast-iron pipe laid from a curved timber cradle suspended between two barges was used for the three most important submerged crossings on the twenty-mile supply main from the Lake Prince reservoir to the water-works distribution system of Norfolk, Va. These streams were the Nansemond River with a width of 2,000 ft. and a maximum depth of 30 ft.; Craney Island Creek, 1,400 ft. wide and 20 ft. deep; and the Elizabeth River, 6,500 ft. wide with a maximum depth in the 750-ft. ship channel of 58 ft. and varying depths of from 47 to 85 ft. from channel to pier head lines.

Flexible-Joint Pipe—After careful consideration of the various types of flexible-joint pipe, it was decided



PIPE CRADLE USED ON ELIZABETH RIVER CROSSING
Length, 150 ft. Made of timber

to use 30-in. cast-iron pipe of the Ward joint type but with certain modifications. These were: (1) The shrinking of a 1-in. by 4-in. steel band around the bell end of the pipe; (2) machining of the spigot end spherical and a uniformly turned shoulder immediately back of the spherical machined spigot; (3) the casting of an extra lead groove within the bell. The steel band was used to insure extra strength to the bell during handling and shipment, and to resist any strains from undue deflection or excessive caulking. The purpose of the extra lead groove was to insure a more perfect bond between the iron and lead after pouring and for the admitted value of extra rabbeting. The shoulder on the outside, in case of excess bending, comes in contact with the cast portion of the bell outside of the lead, taking the strain, and preventing any deformation of the lead by crushing. The spherical lead gasket, cast and locked into the bell, insured at any angle of deflection a full lead joint 8 in. deep. Whereas, when the lead is fixed to the spigot end, the maximum deflection reduces the depth of the joint to 3½ in., and proportionately with the lesser angles, for the gasket leaves the bell on the convex side and recesses in the concave side of the joint in proportion to the leading.

A detailed description of the pipe used on these crossings, written by William Hammerstrom, chief engineer of the Lynchburg Foundry Co., appeared in *Engineering News-Record*, May 11, 1922, p. 780.

General Methods Employed—To conform with the requirements of the United States Army Engineers, and to protect the pipe after laying from possible damage by shipping or dredging operations, trenches were dug across the various streams. In the channel of the Elizabeth River this trench was excavated to a depth of 58 ft. below mean low water, thus giving a cover of 12 ft. over the top of the pipe after the trench is backfilled with sand. To eliminate abrupt irregularities by cutting down the bumps and filling the holes, a rectangular drag weighing approximately three tons, and built of 24-in. I-beams 16 ft. long, was suspended at the required depth from a derrick scow and pulled by cables along the bottom of the trench to the Craney Island shore from the opposite side of the channel.

The submerged portion of the Nansemond River Crossing is 900 ft. long, with vertical risers having flanged fittings each side of the channel. There are two creosoted pile trestles from each shore to the vertical risers. For a short distance upon each trestle from the edge of the channel, flexible-joint pipe was laid, and upon the remaining 900 ft. of trestle, Class B cast-iron pipe was laid.

Craney Island Creek was crossed entirely with flexible-joint pipe. The pipe was jointed in the cradle and launched shoreward through the Craney Island bulkhead to a point above low water, sloping gradually down to the bottom, then across the stream to the opposite bank on the sloping sand beach to high water, and there connected to the previously laid Class B, cast-iron pipe.

On the west bank of the Elizabeth River the flexible pipe was pulled from the end of the cradle shoreward through the Craney Island bulkhead on an inclined skidway to and above the high-water mark. The east end of the 4,100-ft. submerged portion was laid on a sloping grade from the bottom of a 25-ft. dredged cut, up and onto the pipe trestle with reverse vertical curves, avoiding the use of bends or specials. The flexible pipe is run along the trestle for 100 ft. shoreward and there connected with lock-joint concrete pressure pipe, which extends from this point to the shore and thence to the 37th St. filtration plant.

Work by City Forces—The Nansemond River and Craney Island Creek crossings were laid by city forces, employing day labor and working in daylight only. A 100-ft. curved timber-trussed cradle was suspended between two barges: one a flat deck barge, 35 x 110 ft., and the other a derrick scow, 30 x 90 ft. The upper and lower chords of the cradle were built up of 2 x 8-in. heart pine, making two laminated members, 8 x 12 in. each, the struts and diagonals being one piece 10 x 12-in. heart pine timbers. The pipe skidway was constructed of 2 x 8-in.

heart pine, built up to 8 x 8-in. sections, upon which were bolted ½ x 4-in. steel plates as a base for 30-lb. railroad rails set normal to the barrel of the pipe.

The cradle was curved and slung so that the lower end could be kept, at all times, tangential to the river bottom, whatever the depth by raising or lowering the purchase blocks and tackle by which it was suspended.

Contract Work, Elizabeth River Crossing—The Elizabeth River crossing was laid by Sanford & Brooks Co., Norfolk, Va., using a cradle similar in design, furnished by the city, but 150 ft. long. It was slung in the same manner, except that a 40 x 100-ft. derrick scow was used in the place of the smaller one. In each case the cradle was hung from 12 x 12-in. A-frame trusses, built up on the decks of the barges. Large five sheave purchase blocks and tackle attached to the upper end of the A-frames and to predetermined panel points of the lower chords of the cradle furnished easy means of control. To regulate the submerged end of the cradle, two sets of double sheave blocks were attached to a timber placed across the stern of the barges and lower end of cradle.

Six sets of ranges, lighted at night with electric lights, were placed on each side of the river, the center sets marking the center line of the dredged cut and pipe line, and the side sets warning shipping not to anchor within the sector. The United States Coast Guard maintained an efficient patrol at the site of operation, and controlled speed of vessels, thus eliminating danger of injury to the pipe and laying rig from heavy swells.

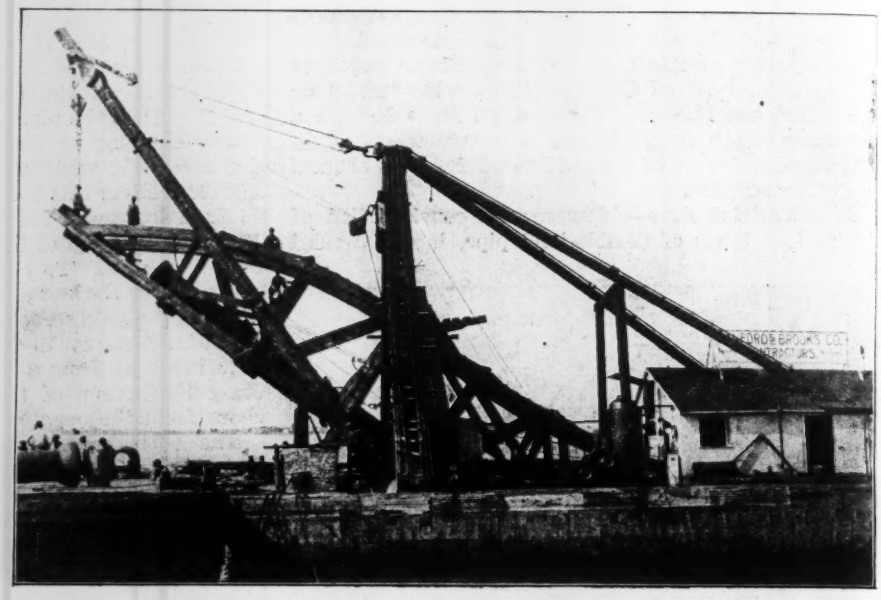
The pipe was delivered upon lighters to the laying rig from the storage yard on the water front. Careful inspection was made by an experienced pipe man, furnished by the foundry, before the pipe was placed upon the lighters, and again just before it was placed in the cradle, to guard against any possibility of defective pipe getting into the line.

Bells Heated—Prior to laying, the bells of the pipe were heated to about 400 deg. F. by the use of a specially constructed device for three reasons: (1) To enlarge the bell; (2) to guard against too sudden a chill of the lead; (3) and to permit the removal of the pitch in the lead space of the bell. Asbestos bulkheads (metal lined), about 8 in. apart, one fitted against the machine ring in the bell and the other against the outside of the bell, confined the heat to the portion that was to be filled with lead.

Through the outside bulkheads were cut four 2½-in. holes into which were placed the nozzles of 5-gal. gasoline torches. After heating, the pipe coating of pitch on the inside of the bell was thoroughly scraped out and the metal left clean, insuring close fit and contact between lead and iron. The machined spigot, which had been coated at the foundry with a mixture of white lead and tallow, was also cleaned and oiled.

Immediately before the pipe was lifted into the cradle with the derrick boom, the bell was again heated to about 400 deg. F. Under usual working conditions, a pipe was laid every thirty minutes so that the bell did not cool materially before the next pipe was placed. As soon as a pipe was "belled," the gasket was put in position and a "mud" gate made ready for pouring the lead joint. The machined spigot fitted the ring in the bell so perfectly that no jute nor inside gasket were necessary.

Special Lead Pouring Pots—Lead pouring pots of sufficient size to hold enough metal to fill a joint requiring approximately 275 lb., and provided with a special bottom valve, were designed by the department and built at a local foundry. They were similar to any ordinary lead melting pot, except for a tapering hole machined in the bottom, into which a tapering rod with hand-wheel control fitted.



PIPE LENGTH IN CRADLE READY FOR POURING JOINT

Upon the derrick barge, a stationary furnace, with twin melting pots large enough to hold the special pot, was built so that the boom could reach it. It was then an easy matter to swing the special pot from furnace to cradle and pour the joint.

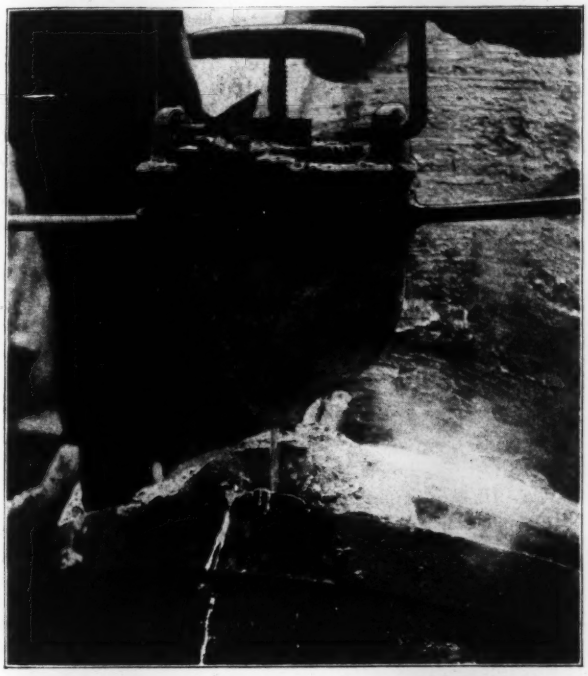
As soon as the lead was poured and before the bell had cooled off the joint was carefully caulked. Then the joint was wrapped with blankets and thoroughly chilled with cold water. After the bell had been cooled, the joint was "broken" (deflected) to allow the pipe to conform to the curve of the cradle and to any irregularities in the river bottom. The "breaking" was accomplished by the use of a 12 x 12-in. timber fulcrum bolted to the struts of the trusses at right angles to the pipe skidway, about 4 in. above the bell of the pipe as it lay on the skidway. A sling, arranged to pull normal to the axis of the pipe, and attached to the boom, then deflected the pipe about 10 deg. out of line. The joints were so stiff that it was necessary to pull the pipe down again to the skidway after the first operation.

Use of Pipe Cradle—The "breaking" operation having been completed, the whole pipe-laying rig was then moved forward 12 ft. preparatory to laying the next

pipe. This was accomplished by pulling on a forward anchor line which exerted a direct motion to the cradle through a bridle line. At the same time the snatch lines attached to the last joint laid in the cradle were slacked off and the pipe allowed to slip down the skidway as the cradle moved ahead. Also the stern and breast lines were controled, as necessary, to hold the cradle in line with the ranges. Care was taken to push the pipe out of the cradle rather than to exert a pull on it as the cradle moved forward to avoid unnecessary stresses upon the lead in the joint.

The experience gained from these operations proved the value of extreme care in considering the details of design, arrangement, and rigging of the pipe laying plant. Unless this care is exercised many important details may be overlooked or discounted for once the work is under way, alteration or correction in either design or rigging is very difficult.

While various methods of approach were used on the several crossings, the most satisfactory was that of



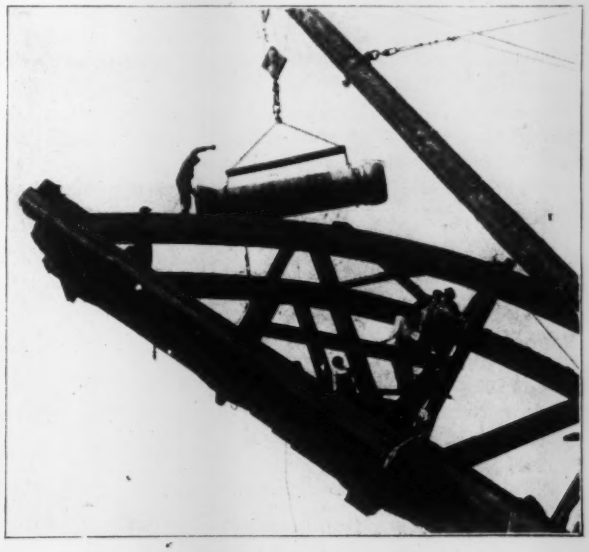
POURING JOINT ON CRADLE FROM SPECIAL LEAD POT
Hand wheel controls tapering rod in lead-discharge hole. Pot holds about 275 lb. of lead.

connecting the submerged pipe directly to the shore lines with gradual curves without the use of vertical "risers" or "bends." This eliminates the danger of side thrust due to pressure in the pipe line.

The heating of the bells brought out the fact that care must be taken in raising them to a moderate temperature only so that it does not interfere with the malleability of the lead after solidification or with cooling the joint within a reasonable time. It was found that when the bells were moderately heated, the joints were considerably stiffer than those poured at either extreme. Cooling of the iron with the resulting contraction of the bells increases the pressure on the lead around the spigot.

During the progress of the work, on all jobs, a careful inspection of the pipe below the water was kept up. At least once during each eight hours the inspector was lowered to a point back of the lower point of the cradle.

Leakage Tests—Preliminary tests under pressures up to the maximum heads for which the pipe was designed do not indicate a leakage in excess of 100 gal. per inch diameter per mile of pipe per 24 hours. These tests are satisfactory proof that the methods employed in these



READY TO MOVE AHEAD A PIPE LENGTH

operations, while permitting an excellent rate of speed, were sufficiently careful to insure good results. The several crossings averaged twenty-one 12-ft. joints or 252 lin.ft. per 24-hour day. The maximum laid during any one 24-hour period was 33 joints in the channel of the Elizabeth River at a depth of 58 ft.

Unit Cost—The Nansemond River and Craney Island Creek crossings were laid by city forces during winter weather at a cost of $10.54 per lineal foot, including cradle construction and rental of floating equipment, but excluding the cost of lead and pipe. The Elizabeth River Crossing was laid by Sanford & Brooks Co., general contractors, at a contract price of $16.17 per lineal foot, including cradle construction and equipment and excluding the cost of lead and pipe. The work was begun July 10 and completed July 29, 1922, making 19 working days of 24 hours each. The work was performed under the direction of Walter H. Taylor, 3rd, city engineer, David A. Decker, as principal assistant engineer, and John O. Miller, resident engineer.

Tree Planting Costs on California Highways

About 8,000 trees have recently been planted along the state highways in California, distributed through six counties. A large number of varieties of trees are used, selection being made on advice of the forestry board to suit local soil and climatic conditions. Of 2,920 trees planted in Yolo County, using nursery stock furnished free by the forestry board at its nursery, the total cost in place was 42 cents per tree. The maintenance cost varies from $50 per annum per mile in the valley sections to over $300 per annum per mile in the desert, according to a bulletin issued by the state highway commission.

Testing Hollow Building Tile

Differences in Test Results Believed to be Mainly in Variation in Apparatus and Technique

By Wm. B. Newhall
Consulting Engineer, Minneapolis

WIDE differences in test results on hollow building tiles as reported by different laboratories led to a comparative study, some months ago, of the methods of testing used. This study, carried out by the writer as consulting engineer for the Northwestern Clay Products Co., showed the differences in results to be due to differences in apparatus and technique. It developed also that the entire subject is still under observation and test in the American Society for Testing Materials, where an authoritative standard might be looked for. Following are some suggestions deduced from this study.

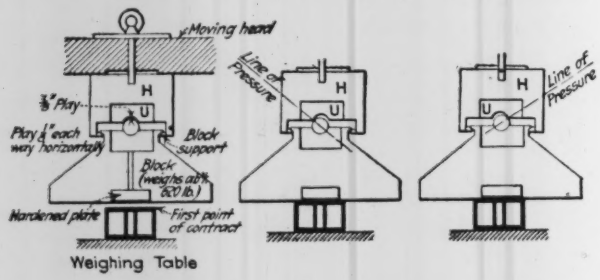


FIG. 1. ORDINARY COMPRESSION BLOCK SEATING ON SLIGHTLY INCLINED SURFACE OF TILE

Left-hand sketch, suspended block about to come into bearing at high corner of tile. Middle sketch, block simply lowered on tile, rotating about high point at corner; line of pressure becomes inclined. Right-hand sketch, result of adjusting block by hand while lowering to bearing, so that bearing face is parallel to top of tile; center of rotation at *c*, near top of block, and pressure line inclined.

Hollow building tile, being a rough product, varies rather widely in strength. This fact tends to induce a carelessness in routine testing that is unfair to the tile. In the testing machine a tile does not have the support it would have in a wall where cross-walls, brick facing, and cement-mortar joints hold it against overturning. Hence the specimen tested to destruction is entitled to be properly bedded, properly placed, and properly loaded in the machine.

Compression tests actually observed bring out three important points:

First, the load applied through the usual form of suspended ball-bearing compression block is usually out of plumb; that is, the compression block introduces a side push not indicated by the machine and of sufficient force to affect the results.

Second, the usual bed of plaster of paris fails before the tile fails, and by flowing sidewise causes the tile to crack first in its horizontal members, by bending, showing the load to be concentrated over the openings.

Third, only those tests that make the vertical webs fail in diagonal shear can be said to have properly developed the strength of the tile. The tile should fail suddenly, all vertical webs at once; not in rotation.

Hollow building tile, being vitrified, can easily be broken by impact, and being hollow can more easily be destroyed when the load is applied at an angle than when applied in the direction of the webs that resist the load. The material is very strong only in straight compression, and should not be subjected to bending or tension or impact.

In Fig. 1 is illustrated the suspended ball-bearing compression block now in constant use on the 400,000-lb. testing machine in the laboratory of the Minneapolis city building inspector. Similar blocks, but of smaller size and much lighter weight, and with almost no play between the suspended part and the upper part, are in use in the laboratory at the University of Minnesota, and probably also in every other laboratory equipped with the usual machinery for compression testing. The design of this block was approved by a committee of the American Society of Civil Engineers and the American Society for Testing Materials, and is illustrated in the 1915 *Year Book* of the A. T. S. M., in the appendix to the standard specifications for portland cement. The block can be made to work perfectly on test specimens having the upper and lower faces exactly parallel, but with the hollow-tile specimens this condition is fulfilled only by accident.

When the block is simply lowered upon the test piece the first point of contact becomes the center of rotation of the block, the ball is thrown out of center, and a side push is introduced and transmitted through the ball to the test piece. When the block is adjusted carefully by hand while being lowered, so as to come down parallel to the inclined top of the test piece, contact occurs over the entire top surface of the test piece at once, but again a side push is introduced because the center of rotation of the block when supported on the flange made for the purpose is above the center of the ball.

Improvement of this condition could be obtained by making the upper cup *U* free from the hood *H*, and allowing it to rest on the ball at all times. Let *H* be turned out enough to allow free side motion for *U*. Then *U* will seat itself automatically against *H* directly over the center of the ball before pressure is transmitted through the ball to the test piece. The side push introduced by the block does not seriously affect solid compression specimens or even tiles with very short thick vertical webs. These fail by diagonal shear, but tiles with ordinary or thin vertical webs nearly always have the webs laid over sidewise without developing their strength, and the weighing levers of the machine indicate only the vertical component of the load applied. A difference of ⅛ in. in the height of a 5 x 8 x 12-in. tile is enough to develop the maximum side push. An angle between the resultant line of pressure and the vertical or true direction of the resisting webs of only ⅛ in. in 5 in. will reduce the total load 20 per cent or more.

In Fig. 2 is shown a simple free ball with two cups. This device is cheaper, easier to handle and more reliable on hollow tile than the ordinary compression block.

According to the A. S. T. M. tentative specifications for testing tile, specimens may be bedded in plaster, either in or out of the machine. The importance of a hard, thin bed is recognized, but no easy way to get it in hasty routine work is suggested. The strength in compression of plaster is much less than that of the tile. This disadvantage is partly overcome by making the bed very thin. If anything stronger and equally convenient to use were known it would be substituted.

Our tests disclosed the fact that when bedding outside the machine on a smooth steel plate, the addition to the plaster of about 10 per cent of portland cement and allowing the bed to dry out over night gives a much harder bed and a better test. More complete experi-

ments along this line are now progressing at the U. S. Bureau of Standards in co-operation with the Hollow Tile Committee of the A. S. T. M.

Our best results were obtained by bedding the tile outside the testing machine between two thick cast-iron plates. The operator can then easily see that he has a thin bed, with the tile properly placed, vertical webs straight up. The plates with the tile between are pushed on to the center of the weighing table, a small free ball bearing is placed on top directly under the center of the moving head, and the load is applied (Fig. 2). This method is quick and easy. Ordinary plaster allowed to set 30 minutes has been used with success, the specimens failing by diagonal shear in the vertical web members every time (Fig. 3). The cast-iron plates used are 2 in. thick and weigh between 40 and 50 lb. It would probably be better to have them thicker for greater stiffness and to core out some openings along the sides to reduce the weight. A good hard-burned tile 5 x 8 x 12 in. weighing less than 13½ lb. can be made to carry a 100,000-lb. load, but it must be properly loaded.

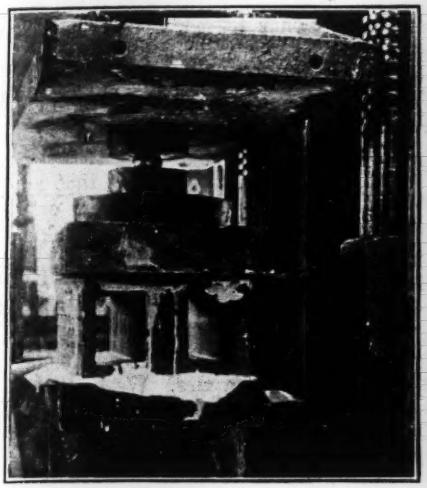


FIG. 2. FREE BALL COMPRESSION BLOCK

5 x 8 x 12-in. tile properly bedded between cast-iron plates; a thin sheet of paper smeared with oil keeps the bedding plaster from sticking to the plates.

FIG. 3. SHEAR FAILURE OF WEBS

Same tile after testing. Parts of the tile have been removed. The upper part of the two middle webs has been lifted off and set down at left. All vertical webs failed at the same time.

It is hoped that the technique for testing hollow tile will soon be perfected and standard methods published by recognized authorities.

Improvements in Railway Coaling Stations

That the design of coaling stations is in the development stage is stated in a brief report presented at the recent annual meeting of the International Railway Fuel Association in Chicago. One line of improvement is to provide for the necessity of handling large quantities of coal economically, and so handling and distributing it that it will not deteriorate in grade. For stations where small quantities of fuel are handled, several forms of equipment are available whereby time and man power are greatly reduced. For large stations, considerable attention is being given to greater storage capacity, particularly regarding the storage adjacent to the plant containing the overhead or supply storage.

Pavement Maintenance Experience in Wichita, Kansas

Cost Given for Five Standard Types — Some Changes in Specifications Appear to Be Desirable

By P. L. Brockway
City Engineer, Wichita, Kansas

MANY paved streets actually receive so little traffic that internal stresses set up by varying temperature and moisture content must be regarded as the real destructive agents. Even the heavier traveled streets last many years and natural destructive agencies have an effect on the pavement that can never be duplicated in an accelerated test. The best proof, after all, is the wearing out of pavement under normal conditions.

Maintenance Costs — The table below has been compiled covering actual maintenance costs of standard types of pavement in Wichita, Kan. Those listed as asphalt include both sheet asphalt and a close asphaltic concrete, together with a compromise mixture, as explained later. Almost none of the asphaltic concrete is more than 4 years old. All of the brick more than 10 years old is repressed block, except some of the oldest, which is of the brick size. All of the brick younger than 10 years is vertical fiber which has required no maintenance except from an occasional crack in the base caused by shifting subsoil. All the pavements listed are on concrete base except the macadam, which is hand-poured asphaltic binder on a sand-filled macadam base.

PAVEMENT MAINTENANCE COSTS IN WICHITA, KAN.

Kind	Area	Total Year-Yards	Aver. Age, Years	Cost per Yd. Per Year
Asphalt	972,622	9,767,413	10.5	$0.0013
Brick	957,524	7,515,630	8.0	0.00015
Concrete	251,812	762,414	3.0	0.0012
Bitulithic	130,136	1,762,068	13.5	0.0018
Macadam	31,552	235,607	7.5	0.00098

The figures in the above table are approximately correct, but like many other tabulations are misleading without explanation.

Asphalt—The oldest asphalt pavement is 32 years and 80 per cent of it is still in use. However, 38,000 yd. 31 years old, 28,000 yd. 28 years old, and 30,000 yd. 18 years old have been replaced within the last few years. All of this pavement was maintained 10 years by the contractors and later allowed to wear out with very little maintenance.

All asphalt pavements 17 years old and less are still in use, but contractors maintained for 10 years pavements from 13 to 17 years old, for 5 years pavements from 4 to 13 years old, for 2 years pavements less than 4 years old. Nearly 40 per cent of all the pavement is

11 and 12 years old and now requires 80 per cent of the maintenance work. About 400,000 yd. of that age, representing varying traffic conditions from about 1,000 vehicles per day on a 26-ft. roadway to 8,000 per day on a useful width of 20 ft., cost $3,200 to maintain in a reasonably good condition last year or $0.008 per yard per year.

Most of this expense is incurred in removing humps and waves in the sheet asphalt. Minor damages are skin-patched during hot weather by simply filling the depression partly full of top mix, trimming off the ridge with a foot-adze and ironing over the whole surface. This is much cheaper than cutting out the whole area and refilling it, as must be done in the worst places.

Characteristic maintenance of the older asphaltic concrete surface is the sealing of cracks. The sheet asphalt surface seems to offer too little resistance to the hammering of heavy traffic and the asphaltic concrete too much resistance to temperature stresses. Of the two failures the cracks are much easier and cheaper to repair. Cracks sealed 5 years ago by cleaning out, pouring full of hot asphalt and annealing with smoothing irons are in 90 per cent perfect repair today.

Brick—The oldest brick pavement is 31 years old, all of it on light-traffic cross streets and nearly all of it resurfaced with sheet asphalt, which is charged to pavement construction rather than maintenance. Brick pavement is difficult to maintain after it begins to wear unevenly because new brick set in worn places do not sufficiently match those adjacent. Practically the only maintenance attempted is the smoothing up of the worst depressions with an asphaltic concrete mix on the old surface. On the other hand the pavement, when it becomes worn so badly that the brick begins to ravel out, has a high salvage value, because it is only necessary to level up the surface with a binder course and cover with a standard sheet or asphaltic concrete surface.

A brick pavement 12 years old on one street covering 48,000 sq.yd. and carrying 10,000 vehicles per day of which about 10 per cent are heavy loads is rapidly deteriorating so that even now it is disagreeably rough. It will probably have to be resurfaced within three or four years. The maintenance per yard per year before that time will probably not exceed the figure in the table. This pavement is now worn enough to illustrate clearly a point which is entirely disregarded in any specification we have seen published. That is, if the brick are laid at an angle of 30 to 45 deg. to the direction of traffic the pavement will remain in a satisfactory condition 50 per cent longer than if laid at right angles. This is a strong statement. It is theoretically correct that rolling contact between surfaces is lighter than square moving contact; practically all high-speed gears are helical. As applied to joints in a brick pavement, the same theory holds and is supported by actual practice.

Concrete—The oldest concrete pavement is 11 years and has had no more maintenance than some only 2 years old. The oldest concrete pavement under concentrated traffic carries 3,000 to 5,000 vehicles per day of mixed traffic, is 9 years old and has very light maintenance. In fact the only maintenance required has been the repair of one joint buckled by expansion and the sealing of cracks with a fat mixture of asphaltic cement and hot sand. We do not know how long that will last, but the oldest seal has been in place 5 years.

Much of the necessary maintenance was on 50,000 yd. laid in 1920 without cross-contraction joints, in line with general practice, with the expectation of sealing the cracks when they developed. We promptly discontinued that practice on account of the psychologic reaction of property owners who cannot believe that pavement that breaks up in a year or two is what they should receive. From an economic standpoint alone it is right to repair the cracks as they develop, but it is discouraging to an owner to ask him to build a concrete pavement when he can walk a block and see it broken at rather frequent intervals with ugly, irregular cracks. That problem, like many others, must recognize the human element. Road engineers and builders must adopt the business slogan "Satisfaction Guaranteed" in order to merit the confidence that any successful business must enjoy. Much adverse criticism of concrete pavement could be avoided by making the cracks straight when it is built.

From our experience we have no doubt that concrete pavement can be maintained in satisfactory condition under any ordinary traffic up to 1,000 tons per day per foot of width used for not to exceed $0.0005 per yard per year for at least 15 years. We have one-half mile of concrete pavement 2 years old carrying an almost solid string of trucks and wagons hauling sand during the construction season on which the belt-finish marks are not yet worn off.

The type of joint we are using has not cost one cent for maintenance and is in just as good condition for traffic as when laid. It consists of creosoted wood blocks of 2-in. commercial thickness set with the grain vertical in the concrete.

Bitulithic—The oldest Bithulithic pavement was built 15 years ago and was replaced this year. It carried about 25,000 tons per day over an effective width of about 35 ft. for the last few years and was in generally unsatisfactory condition for the last five years. Traffic followed one track in each direction on account of the rough condition of the surface. This track developed a rut each summer which was repaired by skin patching at small expense.

No attempt was made to maintain the surface as a whole except in the worst holes, as nothing short of resurfacing the whole street would have been effective during the latter third of the life of the pavement. It was discovered, on removing the surface, that much of the pitch used in the original mixture had settled down onto the base. This is an indication that the old Bitulithic mixture did not carry sufficient filler to hold the bituminous cement properly. The characteristic failure of Bitulithic surface as it wears out is a gathering of the material into round hummocks which produce accelerated deterioration due to impact

A reasonable theory for this peculiarity is that, owing to the lack of filler, the bitumen is not uniformly distributed throughout the mass and the coarser particles in the mixture are therefore unevenly bound together even in separate shovelfuls as the material is spread. Many of the hummocks, when they first appear, are not much larger than the space covered by a shovelful of

material. If this is true, the advocates of mixtures containing 50 per cent or more of material retained on the ½-in. screen, with barely enough matrix to fill the voids so that it becomes necessary to use a squeegee coat to produce a smooth surface, are on the wrong trail.

Compromise Asphalt Mixture—Sheet asphalt pavements with a dense bituminous matrix have demonstrated their wearing qualities time and again. They, however, do not have internal frictional resistance in extremely high temperatures to resist the shoving action of modern traffic because there is not enough large material in the mass to impede its flow. The pull of even a heavy passenger automobile with the wheels sliding in an emergency stop actually drags the paving material along if it will flow at all. This produces the ridges already mentioned. If the surfacing will not flow some of its is torn off, the amount depending, of course, on its resistance to abrasion. An asphaltic surface with plenty of bitumen to hold the filler is not easily carried away in this manner.

The apparent solution, therefore, is to start with the ordinary dense sheet-asphalt mixture with all the bitumen which it will carry and stiffen it by adding a small percentage of material retained in a ½-in. screen, (15 to 25 per cent). By using asphalt of low penetration (40 to 45 in this climate) to add to internal resistance, enough may be used so that the surface will acquire a shiny appearance under heavy traffic. This prevents the carrying away of particles by abrasion even though they become dislodged. If this practice is correct the best specification is a compromise between the ordinary sheet-asphalt and asphaltic-concrete specifications. We are so thoroughly convinced that this reasoning is correct that we paved some of our heaviest-traffic streets in this way in 1919 and are continuing to do so in such locations. While of course it is early yet to reach any real conclusion, there is no indication of either cracking or rolling even under the heavy traffic along a large ice and cold storage plant.

Inasmuch as there is no general backing for the addition of large amounts of coarse material in a sheet-asphalt mixture we are discouraging its use. Asphaltic concrete is, so far, a more or less general term which applies to almost any mixture of aggregate with asphaltic cement which is heated and mixed hot in a mechanical mixer and spread on the street and rolled in place while hot. There is, therefore, plenty of precedent under that title to vary the mixture to suit varying conditions.

Asphaltic Macadam—The asphaltic-macadam pavement was nearly all constructed in 1913 by the penetration method and hand-pouring. While the maintenance cost has been only $0.001 per yard per year this amount has been insufficient to keep the pavement in proper condition. One street carrying about 1,200 vehicles per day is so worn down that it would be possible to put a 2-in. top over it without disturbing the gutters. This means that in not over 5 years more the surface will disintegrate beyond any hope of maintenance. The obvious thing to do would be to cover the whole street with either an asphaltic-concrete surface or with a 2-in. surface of plant-mixed macadam, or a plant mixture of hard limestone, from ¾ in. down, with all the dust retained and all the 96 penetration asphalt it will carry, spread and rolled while hot and covered with a squeegee coat of asphalt and hot sand. The latter surface would not cost over $1.25 per square yard, including all necessary plugging of holes.

In another neighborhood the same kind of pavement, which has deteriorated more from weathering than traffic, could have its useful life doubled simply by giving it a squeegee coat of asphalt and rolling in hot sand. This should not cost over $0.25 per yard. It seems scarcely just to do this work at the expense of the city when the property owners asked for and paid for a cheap surface which was known to be inferior when it was constructed. On account of these maintenance difficulties we are discouraging the construction of this type of pavement.

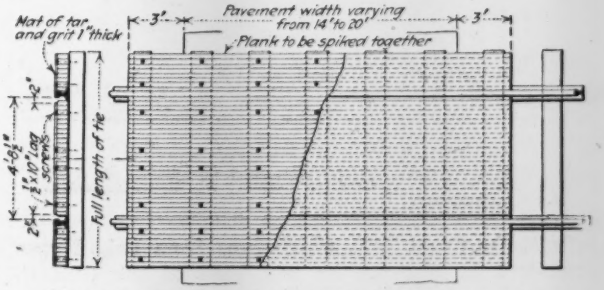
We are, however, encouraging the use of a plant-mixed macadam surface over some of the old water-bound, oil-treated park drives. This is being made by heating a good quality of limestone, all passing a 1-in. screen and with all the dust retained. It is mixed with sufficient asphalt of 96 penetration to make a rather sloppy mass while hot. The mixture has about the analysis shown in the following table.

Opening in Inches	Retained, Per Cent
0.742	10 to 15
0.371	10 to 15
0.185	10 to 15
0.093	10 to 15
0.046	10 to 15
0.0232	10 to 15
0.0116	15 to 20
0.0058	7 to 10
Passing 0.0058	10 to 15

After being rolled a squeegee coat of asphalt, (96 penetration) is placed over the surface requiring about 6 lb. per square yard. This is covered with hot sand and thoroughly rolled. The surface thus produced is much superior to penetration macadam and costs only a little more.

Standard Highway Grade Crossing Ohio State Roads

A SOLID timber flooring the full length of the cross-ties and covered with a tar and grit mat 1 in. thick has met favor with railway officials in Ohio. The drawing shows this crossing as designed by the engineers of the Ohio State Highway Department. As indicated the 2-in. planks are set on edge and firmly spiked together and are fastened down by means of eight lug-screws to each tie. E. C. Blosser, Columbus, Ohio, is state highway engineer.



PLANK GRADE CROSSING OHIO STATE ROADS

Recent Railway Developments in Eastern Africa

Nile and Lakes Linked with East Coast—Labor Gangs of 1,000 Natives on 200-Mile Line—Zambesi Ry. Opened

TWO important railway advances for opening up rich districts in the interior of Africa are the Uasin-Gishu Ry., a 205-mile extension of the Uganda Ry., and the 175-mile Trans-Zambesi Ry., linking an interior line with the coast. Of these railways, shown in Fig. 1, the former is under construction and the latter was completed recently. Further, the former requires heavy construction work while the latter is in relatively easy country.

Uganda Ry—Railway development in East Africa involves heavy grades, curvature and earthwork in order to overcome the sharp rises or terraces which step up from the coast and the deep clefts or inland valleys caused by the subsidence of the earth's crust as a result of volcanic activities. Notable among these

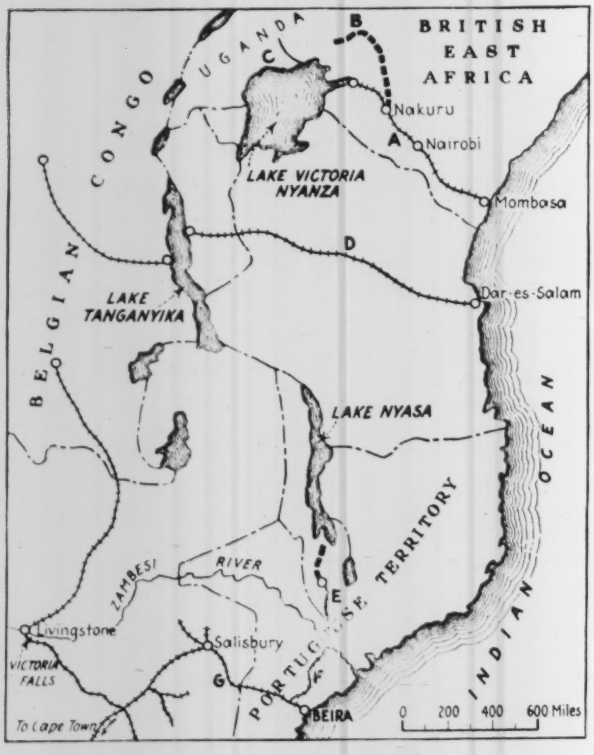


FIG. 1. RAILWAYS IN EAST AFRICA

A, Uganda Ry.; *B*, Uasin-Gishu Ry.; *C*, Busoga Ry.; *D*, East Africa Ry.; *E*, Central Africa.; *F*, Trans-Zambesia Ry.; *G*, Beira Ry.

clefts is the Great Rift, which runs from Lake Nyasa through Lake Tanganyika northeast of the Gulf of Aden and through the Red Sea into the Jordan Valley. This rift, 30 to 50 miles wide, is bounded by lofty precipitous escarpments. At its southern end, the floor is 2,500 ft. above sea level, rising to 6,300 ft. at Naivasha (just south of Nakuru, Fig. 2) and then dropping gradually to the north.

The Uganda Ry. starting from the port of Mombasa rises steadily until it reaches the Kikuyu Escarpment

FIG. 2. UASIN-GISHU RY. (EXTENSION OF THE UGANDA RY.)

station, 346 miles, on the eastern wall of the Rift, at El. 7,400 ft. Thence it drops down the steep slopes to Naivasha, El. 6,011 ft., at 391 miles, and follows the bottom of the valley to Nakuru, whence it climbs the western wall to Mau Summit, 484 miles, at El. 8,350 ft. Then the line falls to El. 3,720 at Kisumu (Port Florence), 584 miles from Mombasa on a shallow backwater of the Victoria Nyanza, known as Kavorondo Gulf. Since Mombasa is not well situated for shipping accommodation its real port is at Kilindini, a little distance to the south. A $5,000,000 contract has been let to Pauling & Co., London, for deep-water piers at this latter place.

The railway was commenced in 1896 and completed in 1903, the work being done by Indian coolies under a government commission. It is a meter-gage line with ruling grade of 2 per cent, uncompensated, and was so located as to require a minimum of earthwork. Its curvature and rise and fall are very considerable. Steel viaducts across the gorges are numerous and were built by an American company (see *Engineering News*, March 14, 1904, p. 345). The track is laid with 50-lb. flange rails on 75-lb. steel ties spaced 2,112 per mile. Up to 1904 the construction cost was $26,585,000, or $45,525, per mile, but in 1910 the capital expenditure had increased to $48,265 per mile. These figures are based on the former normal rate of exchange.

Communication between the railway and the Uganda Protectorate is by steamers on the lake (El. 3,720) but the railway owns two isolated lines in Uganda: (1) Busoga Ry., 60 miles down the Victoria Nile from Jinja (El. 3,750) to Namasagali (El. 3,600), passing a section of the river which has rapids preventing navigation; (2) a 10-mile line from Kampala (El. 3,800) down to Port Bell, at the head of an inlet on the lake. In addition to this east coast route there is a route from Cairo to the Victoria Nyanza by rail and steamer, except for a distance of about 100 miles. On this stretch there is a cleared track which can be traversed by small motor vehicles, rest houses being provided at intervals.

Uasin-Gishu Railway—With the growing importance of the Uganda exports due to native developments and the settlement by Europeans of the highland country to the north of the railway, it became desirable to extend the Uganda line across the Uasin-Gishu plateau (Fig. 2.) Of two routes from Mau Summit and from Nakuru the latter was adopted although it involves a second climb out of the Rift valley. The ruling grade of the extension is 1.5 per cent, compensated for cur-

vature, and the existing line from Nakuru to Mau would have had to be rebuilt to reduce its grades to this limit.

Beginning at Nakuru, 448 miles from Mombasa and at El. 6,070, the new line runs northwest, reaching El. 6,800 ft. at 40 miles and then beginning a heavy climb to the plateau elevation of 8,520 ft. at 76 miles. The summit is near Narasha, El. 9,300 ft. Thence the line crosses the plateau to Eldoret, 122¼ miles, El. 6,860 ft., and then bears west to Turbo, on the Nzoia River, at El. 5,800, beyond which the country rises gradually to the foothills of Mount Elgon. From Turbo the line will turn southwest down the river to a terminal at Mumias, 205 miles and El. 4,270. The whole plateau north of Eldoret is settled and in the Trans-Nzoia district several thousand square miles have been allotted under the British government's project providing settlements for the soldiers of the World War.

Earthwork on the new railway is very heavy and the curvature is considerable, with sharpest curves of 10 deg. As the rivers are small, no long spans will be required, but numerous deep gorges will be crossed

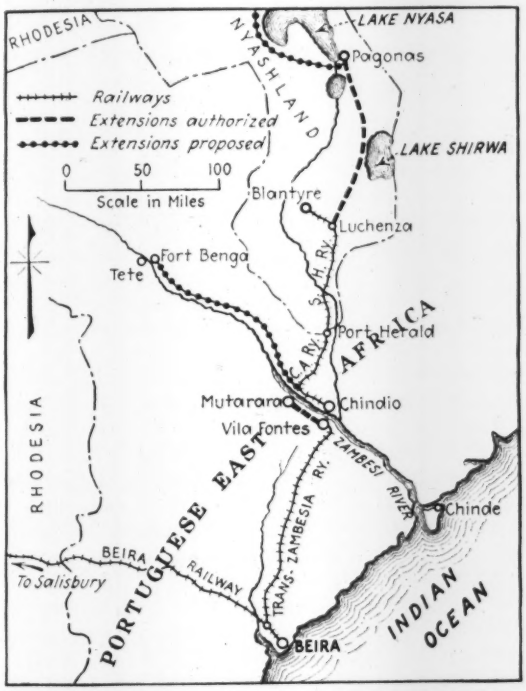


FIG. 3. TRANS-ZAMBESIA RAILWAY AND CONNECTIONS

by steel viaducts, the longest of which are as follows: Sabatia viaduct, 880 ft. with 29 spans of 40 and 20 ft., Nabkoi viaduct, 640 ft., and Sameta viaduct, 450 ft. The line is of meter gage with 50-lb. rails on steel ties of peapod shape.

Unskilled labor is plentiful, but inefficient. Nevertheless, it is not intended to use excavating machinery to any great extent. Skilled labor could be obtained from India, but owing to the prejudice against Asiatics it is probable that such labor will be imported from the south or west of Africa. Since small contractors of a type common in South Africa are not found in this section, the work will be carried on by labor gangs of about 1,000 men, each with its complement of engineers, skilled workmen and medical staff. To each gang will be assigned a length of line sufficient for about two month's work and when this is completed the gang will be shifted to another section. The contractors are Griffiths & Co., London, England, with local headquarters at Nairobi, on the Uganda Ry. Robert J. Halliday is chief engineer for this company.

Trans-Zambesia Ry—This new 175-mile railway completes a 350-mile rail route south from the rich highlands near Lake Nyasa to the seaport of Beira (see Fig 3). Its construction was necessitated by a great change in the Zambesi River. Originally this river was navigable for ocean steamers for about 100 miles to Chindio at the mouth of the Shirè River, from which point the Central Africa Ry. (61 miles) and the Shirè Highlands Ry. (114 miles) form a continuous line of 175 miles north to Blantyre. In recent years, however, the Shirè River ceased to be the main outlet of Lake Nyasa with the result that the level of the Zambesi fell to such an extent that the river is now navigable only by vessels of 5 to 6 ft.-draft.

To overcome this difficulty it was decided to get rail access to the seaport of Beira, the line being a British enterprise but crossing Portuguese territory. The Trans-Zambesia Ry. leaves the Beira & Mashonaland Ry. (running west to Salisbury) about 20 miles from the port and runs practically northward to a point opposite Chindio, where a 2½-mile ferry is in operation. Later the line will be extended a few miles up the south bank to Mutarara, where a bridge will be built. The line is mainly in highly rolling forested country and reaches a summit elevation of about 1,000 ft. at Mile 111, whence it drops by easy grades to 70 ft. at the bridge over the Zangue River. This is the only large structure and consists of five 90-ft. spans. Track is laid with 60-lb. rails and all the lines are on the South African gage of 3½ ft.

A 270-mile extension is proposed westward along the Zambesi to the coal fields of the Tete district. Meanwhile contracts have been placed for a 125-mile extension of the Shirè Highlands Ry. north from Luchenza to Pagonas to connect with steamer service on Lake Nyasa, which is 360 miles long. Work on the Trans-Zambesia Ry. was commenced in September, 1920, and completed in May, 1922, at a cost of about $4,000,000. Sir Douglas Fox & Co. and Sir Charles Metcalfe were the consulting engineers, and Pauling & Co., London, England, were the contractors.

11,017 Miles of Federal-Aid Roads Built

The U. S. Bureau of Public Roads reports that on March 31 there had been completed (since 1916) 11,017 miles of federal-aid road and gives the mileage of each type and the average cost per mile. The figures are based on a large volume of work and are the most recent and reliable figures giving average costs for the whole of the United States. The figures cover the entire cost of construction excluding large bridges and in a few cases the cost of engineering is not included.

Type	Cost Per Mile	Miles Constructed
Graded and drained	$9,200	1,752
Sand-clay	6,850	1,338
Gravel	9,230	4,389
Water-bound macadam	14,000	294
Bituminous macadam	25,720	382
Bituminous concrete	43,500	511
Concrete	36,600	2,104
Brick	46,875	224

These figures are based on the entire period of operation of federal aid but the major portion of the work has been done since 1918.

An Unusual Flood of Eighty Years Ago

Local Scientists Furnish Data for Computing Discharges Amounting to 1,000 Sec.-Ft. per Square Mile

By Ivan E. Houk
Formerly Assistant Engineer, Miami Conservancy District, now City Engineer, Dayton, Ohio

DURING a recent study of rainfall and run-off for the Morgan Engineering Co., the writer had occasion to investigate the records of one of the most unusual floods ever recorded anywhere in the United States; the flood of Aug. 5, 1843, in Delaware Co., Pennsylvania, southwest of Philadelphia. Records of the heaviest precipitation during this storm have been given in various books and papers on meteorology, hydrology and related subjects; but, so far as is known, no account of the storm, or of the flood it caused, has ever been printed in any very accessible publication.

The more unusual conditions connected with this remarkable phenomenon may be summarized as follows:

1. The most intense rainfall amounted to about 16 in. in three hours.
2. An average precipitation of as much as 10 in. in three hours must have fallen on an area of from 50 to 75 sq. miles.
3. Flood stages in Chester, Ridley, Crum and Darby Creeks were higher than during any other flood recorded in the last 175 years, in one instance being as much as 8 ft. higher.
4. A maximum rate of run-off of about 1,000 sec-ft. per square mile occurred from an area of about 62 sq. miles in the Chester Creek Valley.
5. Maximum rates of run-off nearly as great occurred from somewhat smaller areas in the Ridley, Crum and Darby Creek valleys.
6. Tornados occurred in different parts of the county.

Immediately after the flood, the Delaware County Institute of Science, Media, Pa., appointed a committee of three, of which Dr. George Smith was chairman to investigate and collect information regarding this unsual phenomenon. Their report, consisting of 52 closely-printed octavo pages, was published in pamphlet form. The original edition becoming exhausted a few years ago, the report was reprinted by the Institute in their proceedings of October, 1910 and January, 1911. The latter edition, supplemented by personal field investigations, furnishes the basis for the following discussion.

Apparently, this was one of the most unusual thunderstorms ever known. In fact, the descriptions of the local observers, recorded by the committee, lead one to believe that it was the result of two or more separate storms moving in different directions until they finally came together. That such was the case is also indicated by the tornados which occurred in different places and by the general wind movements during the intervals in which the heavy rain fell. Thunder and lightning were said to have been almost incessant.

The heavy rain lasted about 3 hours, beginning between 2 and 3 p.m. in the different part of the county and ending between 5 and 6 p.m. It was preceded by a comparatively light general precipitation which began about 7 a.m. and which amounted to only 0.5 or 0.75 in. During the period from 2 to 6 p.m. the rain seemed to fall in continuous showers of varying intensity, some of the showers being so intense that objects only a few yards away could not be seen. The most intense showers seemed to occur at different times in different places, the general movement being nearly parallel to the stream channls and from source to mouth, thus intensifying the run-off.

The unusually heavy rain fell mostly in Delaware Co., between Cobb's Creek on the east and Brandywine Creek on the west, thus including the territory drained by Darby, Crum, Ridley and Chester Creeks. While the storm extended short distances into Chester and Montgomery Counties and into the State of Delaware, the whole area which was inundated did not exceed in size the county of Delaware, about 185 sq. miles. The precipitation was not unusually heavy along the Delaware River.

In Newtown Twp. the heavy rain fell between 2 and 5 p.m. amounting to from 11 to 13 in. At Newtown Square, immediately before 5 p.m., 5.5 in. fell in 40 min. At Concord, Concord Twp., where the heaviest precipitation occurred, about 16 in. fell in the 3 hours beginning at 2:45 p.m. At Brandywine Hundred, Del., about 10 in. fell in 2 hours.

Unfortunately the above noted depths of rainfall were not measured in rain gages, no stations being maintained in those localities at that time. Consequently they are somewhat open to question. That the rainfall was very great, however, is indicated by the disastrous floods that occurred. In and near Philadelphia no serious flooding resulted although the rainfall, accurately measured in rain gages by trained observers, amounted to from 2 to 5.8 in. At Haverford School, Haverford Twp., a few miles northwest of Philadelphia, where the flooding was not at all abnormal, a depth of 5.82 in. was measured in a rain gage kept by that institution. A careful study of the descriptions given by the committee indicates that as much as 10 in. in 3 hours must have fallen over an area of from 50 to 75 sq. miles

The accounts of the floods in Chester, Ridley, Crum and Darby Creeks, and of the damages they caused, are about what one would expect after reading the descriptions of the storm. Maximum stages for a period of about 175 years occurred in many places, the heights at some sections being as much as 7 or 8 ft. higher than ever before known or than has occurred since. Conditions were worst in the lower part of the Chester Creek valley. One noteworthy circumstance connected with the flood was the almost instantaneous rise of from 5 to 10 ft. which occurred in several places. This took place after the creeks had overflowed their natural banks, so that the amount of water required to cause such a rise was unusually great.

Nineteen lives were lost; 30 dwelling houses, 8 factories, 7 mills and 20 other buildings were washed away; 53 mill dams were either entirely swept away or very seriously damaged, and 32 county bridges were either entirely destroyed or very seriously damaged. The total property loss was estimated at $238,000. Of course, the damage would have been much greater if the valleys had been more thickly populated. The towns and villages are all located above the flood plains.

The writer calculated the maximum rates of discharge for the locations where cross-sectional data had been secured by the committee. Velocities were estimated after a personal field inspection of the locations and a

study of the channel slopes. Drainage areas were measured on the U. S Geological Survey topographic quadrangles. The results of the calculation are as follows:

Stream	Drainage Area in. Sq.Mi.	Rate of Run-off in Sec.-Ft. per Sq. Mi.	In. per Hour
Chester Creek	62	1,000	1.55
Ridley Creek	20	750	1.16
Crum Creek	22	410	0.64
Darby Creek	48	580	0.90

While the above values are somewhat uncertain, it does not seem likely that they are as much as 50 per cent in error. It is believed that such errors as do exist are negative rather than positive; that is, that the values given are too small rather than too large. It is to be regreted that the run-off rates cannot be determined more accurately; but, considering the unusual magnitude of the floods, it is believed that the above data are worthy of presentation.

The work of the committee in measuring and recording flood heights, areas of cross-sections, head at bridges and other hydraulic conditions, cannot be too highly praised. While their methods were somewhat crude in comparison with present day surveys, and their deductions not always warranted, the thoroughness and care with which their work was done indicates that their data are not greatly in error.

English Now Firmly Established in Engineering Courses

Survey Shows Variety of Courses in Composition, Literature and Technical Writing—Recognized as Fundamental

By C. W. Park
Professor of English, College of Engineering and Commerce, University of Cincinnati

IT IS not many years since there was considerable discussion of the question, "Is English a fundamental subject for engineers?" The negative opinion was represented not so much by outspoken denial as by neglect either to make English a required subject, or to insure its effectiveness where it was required. Hence, the aim of those who advocated English for engineers was primarily to secure for it a larger proportion of time and a stronger administrative emphasis.

Whenever the question was fully discussed, there was substantial agreement as to the benefits which might be obtained from the study of English. These included: (1) A knowledge of correct form, in grammar, spelling, and the mechanics of expression—matters which, unfortunately, the majority of the preparatory schools have never adequately covered. (2) Training in thinking, through drill in logical definition and analysis. (3) Skill in the use of language as a tool, through the writing of notes, papers, magazine articles, and business letters, and the written or oral presentation of technical discussions: (4) A background of literary knowledge and appreciation, which would furnish not only private enjoyment but also a link between the professional and human interests of the engineer.

The achievement of these four objectives, or any of them must depend in large measure upon the total time given to the study of English. It is true that more rigid entrance requirements might enable the students in some colleges to start farther along, and that more efficient methods of instruction might enable them to make more rapid progress than in the average engineering school. Assuming entrance requirements and teaching efficiency to be approximately uniform for the various colleges, however, a valid common denominator for comparison would be the proportion of time given to English of all credit hours required for a degree.

Minimum Freshman English—As a typical case, assume a four-year course averaging 18 credits per semester and requiring total of 144 credit hours for the bachelor's degree. If English is required three hours a week for one year, or 6 credit hours, the proportion of the total time would be approximately 4.2 per cent. This appears to be the minimum allowance for the standard freshman course in English composition, which is given in all departments of practically every American college. Since this standard course rarely includes more than objects one and two, it is evident that a larger proportion of time is needed if any provision is to be made either for the technical applications of English or for the study of literature.

On the basis of the foregoing estimate, the status of Engineering in 65 engineering colleges in the United States is encouraging. Of this number, as shown by a survey recently made, 47, or 72 per cent, allot more than one year, and more than 4.2 per cent of the total time to English, and require instruction in either literature (31) or techincal composition (30) or both (13). In addition to these studies, public speaking is required in eight colleges. The average proportion of total time for English in the group is 5.8 per cent.

The figures given above refer only to studies required for the technical degree. Nineteen colleges offer electives which may include courses in English, and at least nine of these specify courses which are designed to appeal particularly to engineering students. Since the results obtained by elective courses vary from year to year and from school to school, a truer picture of conditions is gained from statistics on the required courses.

Although there is still room for improvement, particularly in the addition of courses dealing with general literature and with the applications of English to technical writing, the situation is more favorable than it has ever been. Many colleges have recently added courses in English for engineering students, and have identified the instruction in this subject more closely with the technical studies. From the lists of requirements for engineering degrees, it would appear that English is now very generally recognized as a fundamental subject. The present task of the teacher of English is not so much to propagandize as to make the most of the opportunity placed before him.

Rock-Fill Causeway at Singapore

To extend railway service into the city of Singapore and eliminate the present ferry service between the island and the mainland a rock-fill causeway across the Singapore Strait is being built by the Federated Malay States Rys. This embankment will be about 3,480 ft. long, in water about 47 ft. deep at low tide. It is of granite rubble construction with a top width of 60 ft. for a double-track railway and a 26½-ft. roadway, the latter having a concrete parapet wall on the outer side and a fence separating it from the railway. An opening for small craft will be left and as the water may be at different levels on opposite sides of the causeway there will be a lock 170x32 ft., with 10 ft. of water on the sills.

Cement Prices Not Unduly High

Analysis of Prices and Costs Based on Earnings, Elements of Cost, and Comparison with Other Building Materials

By Lowell R. Burch

Assistant to the President, Atlas Portland Cement Co., New York

THE issue of *Engineering News-Record* for June 1 contained an editorial in which appeared the following statement: "Brushing aside all generalities, what the cement consumer wants to know is whether he is paying more for cement than he ought to." Undoubtedly, the consumer should have authentic information on this point. We believe the actual facts as to the cost of manufacturing and the selling price of cement are of public importance. It is held by many that the suspicion that building costs are excessively high is preventing necessary construction and having a consequent effect on the prosperity of the country. Any

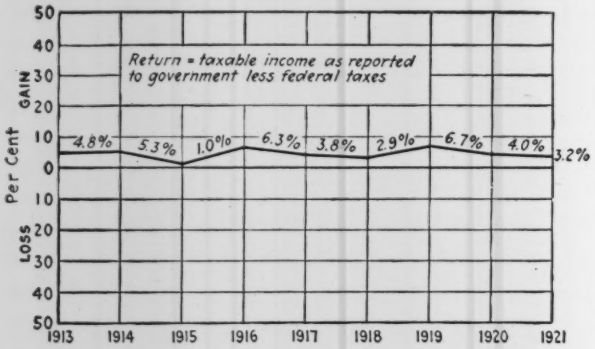


FIG. 1—RETURN ON INVESTMENT OF 19 COMPANIES

Average percentage earned on invested capital by 19 companies in northeastern states, based on income-tax returns.

light, therefore, that can be thrown on the subject should be of value.

It has always been difficult to collect figures and data concerning costs of building materials in general, but by delving into the publications of various government departments, culling over the reports made by the cement companies themselves during the several investigations of their industry, we have developed what we believe to be an accurate statement as to portland cement. In instances where sufficient data were not available from the above-mentioned sources, we have made use of the records of an individual cement company. The writer of this article being connected with the Atlas Portland Cement Co., that concern has been used.

The value of any figures, or statements derived from them, must depend upon the accuracy of such figures. For this reason the information collected here is believed to be especially valuable, because its accuracy is beyond question.

There are three natural approaches to this subject: One is to take earnings on investment as reported to the government for income-tax payments. The second is to build up the cost of actual operation; that is, show how much is secured from the sale of a barrel of cement and how that money is divided up. The third is, by comparison of cement with other products, such as its relationship to other materials in the "price curve." In order to make our survey complete, we shall utilize all three of these methods.

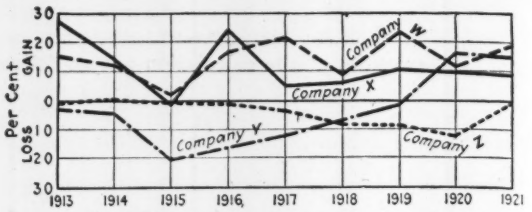


FIG. 2—RETURN ON INVESTMENT OF 4 COMPANIES

Individual earnings of two most profitable companies and losses of two heaviest losers.

Earnings on Investment—Fig. 1 shows the average percentage earned on invested capital by nineteen cement companies operating in the northeastern states from 1913 to 1921 inclusive. This is based upon reported income-tax returns of the respective companies. It will be seen that in the best year, 1919, the earnings were 6.7 per cent before dividends on stock had been paid; and it would be well to note particularly figures for 1920, because the 4 per cent shown there certainly indicates that the so-called profiteering of that year found no reflection in the cement companies' income.

Possibly, the chart will bring forth the comment that the total earnings are low, because a few companies show big losses, probably due to bad management, but that some companies must have made enormous profits. It is true, of course, that some companies made more money, much more in fact, than the averages shown on this chart, while some other companies showed substantial losses. Lest this impair the real value of the chart, another chart, Fig. 2, has been prepared showing the individual earnings of the two best money-makers and the losses of the two "worst" losers. The two companies showing the best earnings average only 13 per cent over the entire period under consideration. The best year for any individual company was in 1913 when company X shown on the chart earned 27 per cent on invested capital. The difference in profits is attributable mainly to natural advantage, although this is

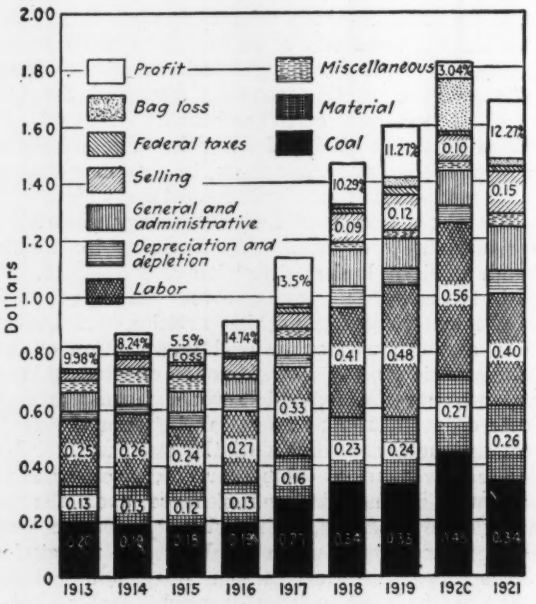


FIG. 3—ELEMENTS OF COST IN A BARREL OF CEMENT

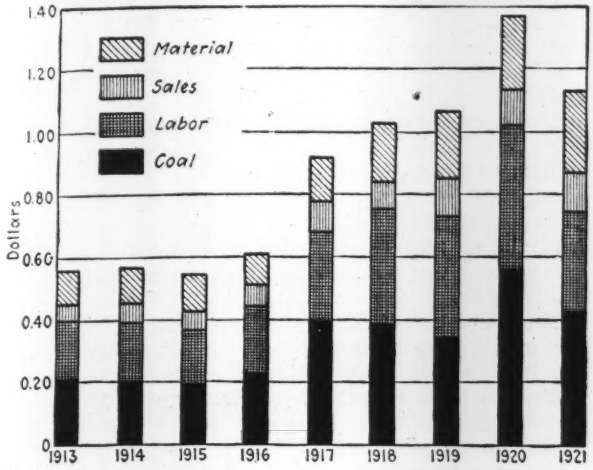


FIG. 4—THE FOUR PRINCIPAL ELEMENTS OF COST
Based on records of 17 Eastern companies and expressed in dollars per barrel.

not in any way meant to detract from the credit belonging to those responsible for good management.

This chart of the two best and two worst results is given only to counteract the impression that the remarkably low average figures might awaken. The vital fact is, that the average return on invested capital is low.

These figures have appeared in court and are accurate. They contain no subterfuge, earnings are not hidden by high salaries, and above all, the invested capital shown is much less than the replacement cost of the properties. Much information could be given to prove this statement, but we cannot cover all points in detail. The invested capital upon which Fig. 1 was based was less than eighty million dollars in 1921, having increased since 1913 only about fifteen million dollars.

It would be well to point out here that there are very few, if any, industries where the investment per unit of sales is so great. In the course of testimony given by an expert, it was brought out that it takes more than

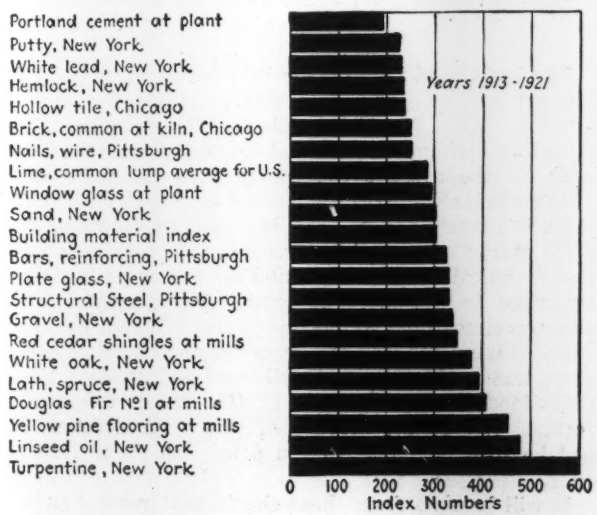


FIG. 5—PEAK PRICES OF MATERIALS, 1913 TO 1921
Maximum wholesale prices of building materials by index numbers based on 1913 average as 100.

$2.50 of capital investment per barrel of annual output. Thus, a million-barrel plant has an investment on the present replacement costs of substantially more than two and a half million dollars; and a ten-million barrel company has an investment which at the present time would have a replacement value over twenty-five million dollars.

This statement may be further clarified by quoting the Geological Survey: "The rate of turnover of capital is necessarily much faster in the iron industry than in the cement industry, in which the rate of turnover is practically slower than that of any other industry. In other words, if the profits per ton were 10 per cent of the selling price of both pig iron and cement, the returns to the producer in the case of the iron industry would be 15 to 20 per cent a year profit, while in the

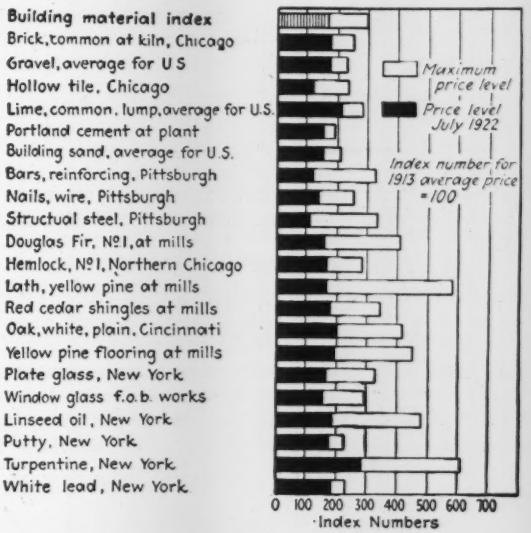


FIG. 6—RELATIVE PRICES OF MATERIALS FOR JULY, 1922
Wholesale prices of building materials by index numbers based on 1913 average as 100.

cement industry the same capital would produce only 5 per cent profit."

Analysis of Average Price Received—In covering point one we had a relatively simple problem. Point two, on the contrary, is so much involved that it is hardly possible to discuss it within the limits of a single article. A book could be written about cement costs; in fact, the costs in almost any commodity present such an involved problem that a thorough explanation is impossible within reasonable limits of space. To average every item for all the companies is out of the question, because no two companies have exactly the same system of accounting. Hence, we have limited ourselves to the complete cost sheets of a representative individual company.

Fig. 3 shows in detail the various elements that make up the price of a barrel of cement. Actual figures appear in the columns of the principal items. In the profit section of each column appears the percentage of profit on the average price received per barrel. Fig. 3 otherwise is as nearly self-explanatory as it is possible to make it.

Fig. 4 shows the four principal elements entering into the cost of cement, collected from records of seventeen Eastern companies, from 1913 to 1921 inclusive, the

items taken being coal, labor, material and selling. It is interesting to notice the increase in the cost of all of these. That there was not a greater increase in some of the items, coal for instance, was due to large purchases made at low prices.

It is perhaps well to mention here that when we read in a trade publication that cement is, let us say $2.50 per barrel, which is about what the dealers in New York City were paying in June, it does not mean that

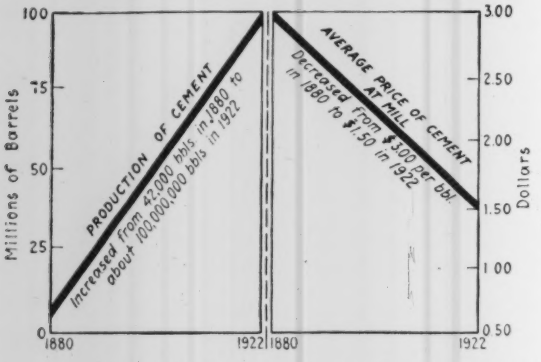


FIG. 7—OUTPUT COMPARED WITH PRICE, 1880 TO 1922

Data from 1880 to 1921 inclusive from U. S. Geological Survey. Figures for 1922 estimated.

the manufacturer actually received that price, or anything like it. We must deduct bags, freight and discount. Let us assume a freight rate of 38c., bags 40c., and discount 10c. This would bring the manufacturer's price down to $1.62. The bags, it must be remembered, are returnable to the manufacturer at the price paid. Furthermore, prices quoted in these publications frequently include delivery, such as truckage, etc., to the job.

The U. S. Geological Survey publishes each year the average prices received by cement manufacturers for all their shipments. These government reports show that the average prices received by the mills in the Lehigh Valley District were: $1.64 in 1919, $1.91 in 1920 and $1.72 in 1921. In the extreme peak of the building congestion it will be noted that the average price received was only $1.91 which was the highest average price received during the last decade for the Lehigh Valley mills. While stories of profiteering are most certainly answered, so far as the cement industry is concerned, by this record, what profiteering there was can be traced to a few persons who speculated in cement. Undoubtedly, cement did not escape entirely the bad practices which were then rampant, but the manufacturers, as has been shown, did not participate. More than that, the records indicate that practically no manufacturer accepted anywhere near so high a price as he could have got had he so desired.

Relation to Other Materials—As to the third point: What is the actual relation of cement to other commodities? In this period of inflation how did cement perform? Fig. 5 shows the peak of prices of building materials between the years 1913 and 1921, inclusive. Cement has the best record of all. Fig. 6, which is of more immediate interest, shows where cement stands today, in relation to other building materials. The cement business after the war just began to come into its own. During 1917 and 1918 it was curtailed along with other building materials. However, building activity began early in the summer of 1919 and since then the demand for cement has been extremely heavy. The industry was not affected by the depression of 1920 and 1921 as was the country in general. In fact, 1920 was the record year in shipments with 1921 only a short way behind, while 1922 has broken, so far, all shipping records, with indications that if the strike permits, shipments will continue at the present unprecedented rate. In spite of this demand, prices are much lower now than at the peak, even though the cement peak was not nearly so high as the general commodity peak.

There are two other ways of approaching this question of the price comparisons of cement. Fig. 7 shows the increases in consumption of cement and the decreases in price since 1880, eliminating the yearly and seasonal fluctuations. If cement was a valuable commodity in its early stages—and it must have been or its use could not have so tremendously increased—it is vastly more so now.

Fig. 8 worked out by Edwin C. Eckel, formerly of the U. S. Geological Survey, shows the true price of cement. This is an interesting study, as it gives the price of cement in terms of actual comparative values, rather than in money.

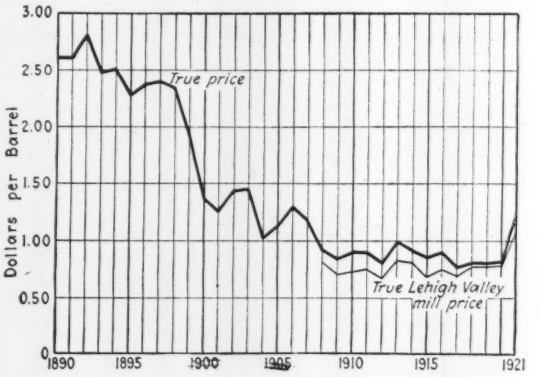


FIG. 8—TRUE PRICE OF PORTLAND CEMENT

Cement prices from 1890 to 1921 expressed in terms of other commodity prices, thereby eliminating fluctuations in currency value.

The basis used to establish this comparative price is the average of commodity prices during the period covered. What Mr. Eckel calls the "true" price is obtained by dividing the nominal or money price for each year by the average commodity price index-number. This method eliminates the variations caused by fluctuations in currency value. As Mr. Eckel points out, the price course of cement analyzed in this fashion shows that technical improvements and economies permitted a reduction in the price of cement as compared with other commodities for many years. When the full effect of improvements and economies had been realized, there was no longer a possibility of independent price reductions. From that time (1910) cement prices conform closely to the average of other commodities, as will be seen by following the price line from 1910 to 1921.

It will be seen from these charts that cement prices considered either from actual or comparative points of view, are extremely low. This becomes all the more

impressive in the light of the fact that the manufacture of cement is not simple, but is an involved process requiring a costly plant.

Considering the enormous amount of capital required to be invested, the rapid rate of deterioration and consequent high cost of upkeep, the multiplicity of operations through which the rock goes from the time it is quarried until portland cement is produced, the care required in grading, blending and testing to produce a uniform product meeting exacting specifications—considering all of these things—the real cause for wonderment is that cement should be the cheapest manufactured building material.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Highway Location Near Levees

Sir—Many miles of gravel road have been constructed in Louisiana immediately behind levees built to protect a large part of the state from overflow when the Mississippi, the Red, the Atchafalaya and other smaller rivers and bayous are in flood stage. These levees are almost invariably located in a series of tangents with angles that make it impossible to get any respectable alignment for the highways without cutting up the property behind the levee. In several places in Louisiana houses and buildings are so thick along rivers and bayous behind levees that a message could be called from place to place for upwards of 50 miles.

The time is rapidly approaching when our gravel roads will have to be replaced with a more durable type of pavement and the question of location becomes very important in the case of a pavement costing from $25,000 to $40,000 a mile. If the levees were located and laid out with tangents and curves of a minimum radius, it would then be possible to get a fairly good alignment for the highway immediately behind, but this would not materially help in the matter of distance where the levees follow the general directions of the rivers and bayous, crooked as they are. Such a levee location would, however, materially decrease the length of levees required and would effect a substantial saving in the land required to build the levee and for the borrow pits necessary to get material.

The problem of seepage water during flood stages can be successfully solved with a small parallel ditch between the highway and levee 1 ft. deep, not closer than 5 ft. to toe of levee, with adequate openings through the road every 500 to 1,000 ft. and with another larger parallel ditch on the land side of the road that will collect seepage and rain water and distribute it to ditches and canals leading away from the highway through the fields to the lower country. The grade line on a highway immediately behind the levee should not be less than 1½ ft. above the natural surface of the ground.

The question as to proper location can therefore finally be argued from two sides, one location immediately behind and paralleling levees and another location well back away from levees. The location alongside the levee would be longer, have more curvature, but would be more convenient to existing developments and contribute hugely to the safety and integrity of the levee system during stages of high water, such as we have just gone through this year. A location back and away from the levees would be much shorter and consequently cheaper and would not be subject to changes and reconstruction when it becomes necesssary to move a levee back on account of caving banks or channel change of the river or bayou. When our levees are moved back they generally occasion a very difficult condition to be met in locating or relocating a highway. Acute angles prevent a clear line of sight and many accidents have occurred in such places.

During the unprecedented stages of high water of 1922 the presence of improved highways close to the levees has proved of incalculable benefit and in more than one case the epochal fight of 1922 to save the levees could not have been won except for the presence of roads over which it was possible to haul men and materials when delays would have spelled disaster. With reasonable concessions from levee builders in the matter of alignment of their works, a good hard-surfaced highway following closely the lines of levees, except where the river or bayou makes a long detour, would constitute an indispensable asset to the integrity of the levee itself in times of high water.

When all levees have been brought up to commission grade and section they still require constant and careful inspection and attention during floods. Sand boils, sloughs, and wave wash will continue to be the order of the day and men, sacks, lumber and tools will be rushed to points of danger. This can be done quicker and more effectively on the land side than on the river side of a levee with a good road close by.

It would then seem that our highways should follow as closely as possible to the levees to form a second line of defense in time of flood, but not closer than is consistent with good alignment and reasonable distance.

Moreauville, La. L. A. SUMNER,
July 29. Construction Engineer, Louisiana Highway Commission.

Teachings of Bridge Failure

Sir—Your issue of August 10 contains an article, p. 238, entitled: "Bridge Abutment Crumbles, Wrecking Span," by C. S. Stewart, describing a failure which suggests three important lessons, two of which I would comment on as follows:

1. As the result of the fall of the pin-connected span, it is stated "The truss except for the last panel appears to have suffered little damage." Pin-connected construction has not received the credit which is its due in the light of experience, and I believe a more general use of it will follow proper considerations of economy and the superiority of connections fitted in the shop over those made in the field.

2. Some varieties of limestone of good appearance are liable to go to pieces in time, as in this abutment when used in the masonry of bridges. I have seen several that required replacement through the gradual development of innumerable cracks in the stone.

GEORGE H. PEGRAM,
New York, Aug. 24. Chief Engineer, Interborough Rapid Transit Co.

Pumping Plant on Incline Moved to Suit Water Level

Sir—In the *Engineering News-Record*, June 22, p. 1027, is an article "Pumping Plant on Incline Moved to Suit Water Level." This is not a new idea by any means as the Illinois Central R.R. Co. has had this type of pumping station in service for many years.

A pumping station with a capacity of more than 200,000 gal. per day built on an incline for raising and lowering pumps was established on the Cumberland River, Kentucky, in 1898, and abandoned in 1908 when the water station was moved from that point. The writer also built a pumping station of the same type at West Point, Ky., on the Salt River in 1902. This plant also had a pumping capacity of 200,000 gal. per day. It was built in 1902 and is still in service. An ice plant at Paducah on the Ohio River has had a plant of the same kind in service for more than 30 years.

C. R. KNOWLES,
Chicago, July 14. Superintendent Water Service.

NEWS OF THE WEEK

New York, September 7, 1922

Release 34,000 Cars From Coal Preference on A.G.C. Plea

Washington Correspondence

Thirty-four thousand additional open-top railroad cars have been released from preferential loading with coal. This was accomplished by an amendment to the existing priority order which excludes from the cars on which the coal mines have first call those with sides 42 in. or less in height. Under the original priority order, open-top cars with sides less than 36 in. in height were exempted. Under that order 62,000 open-top cars were made available for loading with commodities other than coal. The exemptions apply only to cars with fixed bottoms. All hopper-bottomed cars are reserved for coal loading.

This action followed representations by the Associated General Contractors. That organization urged that more cars be made available for the movement of construction materials and the other commodities which require open-top cars. In a letter to General R. C. Marshall, Commissioner Aitchison among other things said:

"This action on the part of the Interstate Commerce Commission should not be taken as our final word on this subject, but with the present and necessary demands for coal, it is not felt that we consistently can go further at this time. We will continue, as we have in the past, to keep in daily touch with the situation and as soon as we feel that the situation warrants, action will be taken to relax our service order. We will be glad, in the meantime, if you will keep us informed of the general situation and of any exigencies which might require special attention."

Trade Commission Files Complaint Against Steel Merger

In a formal complaint issued Aug. 31 the Federal Trade Commission charges that the proposed merger of the Midvale, Republic and Inland steel companies, announced some time ago, is an unfair method of competition and in violation of Section 5 of the Federal Trade Commission Act. The Midvale Steel and Ordnance Co., Philadelphia, the Republic Iron and Steel Co., New York City, and the Inland Steel Co., Chicago, are named respondents in the complaint. They are given thirty days in which to file an answer.

The gist of the complaint is that the Commission, after a preliminary inquiry conducted by it, has reason to believe that the consolidation of these three competing companies, which will center the control of some 35 corporations in one group, will eliminate competition between the companies, and lessen competition, restrain trade and tend to create monopoly in iron and steel products in interstate commerce, particularly in Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan and Illinois.

Price Inflation In Construction Industry Will Prove Boomerang, Says Roosevelt

President of American Construction Council Stresses Need of Stabilization in Letter to 200 National Organizations—

Having in mind the extraordinary advance in wages and prices which attended the boom in the building industry in 1919-20, Franklin D. Roosevelt, president of the newly organized American Construction Council, has addressed the presidents of about 200 national organizations in the construction industry with a view to preventing a secondary inflation which, he believes, would inevitably be followed by a slump in business such as that which occurred in 1921 and which would more than offset any profits from another period of skyrocketing. In addressing these national organizations Mr. Roosevelt, said:

"The extraordinary postwar era of prosperity which came to a peak in 1920 and was characterized by mounting prices, advancing wages and increasing volume of business went so far that the slump which followed it in 1920 was inevitable. Again, the great demand for products, and especially construction, has started us on an era of higher prices and higher wages. Inflation seems imminent. Will reaction follow?

"Wholesale prices have risen again from 138 to 150, building materials from 155 to 167. Wages did not go up as fast as prices in 1919 and 1920, but they gathered momentum as they went and continued upward after prices began to come down. Some reductions from the peak have been made, but again there is a tendency to advance. Expressed in simple terms this means: If we are to keep construction activity steady and stable for the next 5 years, in view of the volume of work which should be done, we must consciously avoid periods of sky-rocketing, either in prices or wages. While the demand for the moment may make possible unusual prices and wages, it will only prove a boomerang if the public decides to stop buying again. Isn't it better to forego temporary advantage if, by so doing, industry is kept moving at a steady, stable, healthy pace continuously?

"I urge your thoughtful consideration of these suggestions and request your co-operation in helping to maintain stability in the construction industry."

This note of warning has met with universal approval and it is being passed along the line by means of the official publications of the various organizations to the members. From the responses received the following are quoted:

American Farm Bureau Federation—"I congratulate you on your efforts to hold prices and wages in the construction industry within reasonable limits. It has been gratifying to note the revival in building, but the ensuing rise in prices is lamentable. If you can make the industry which you represent understand that agriculture is prostrate, that 30 per cent of our population cannot be normal customers of their industries, and that your industry should bend every energy toward an equitable readjustment of its affairs, you will be performing a high national service."

American Bankers Association—"The future stability of American business will not be enhanced by too great expansion at this time, either in production cost or selling prices. Labor, unfortunately, is apparently determined to, so far as possible, maintain wages at war-time levels, which tendency is putting too great a burden upon our great army of consumers, especially agricultural, whose incomes have been materially reduced since 1919."

American Face Brick Association—"While the clay-working profession has never been accused to any extent of profiteering, we wish to be sure that nothing is left undone by us that will in any way help to bring about a steady

Washington Sees Need for Change in St. Lawrence Project Plans

Washington Correspondence

That Canadian apathy in the matter of the development of the St. Lawrence cannot be overcome without some alteration in the plan proposed by the International Joint Commission is the belief held in official circles in Washington. The interest of the President in this project is so great that it is believed he will find some means of making the proposition more attractive to Canada.

Lack of interest in Canada is attributed to railroad facilities in excess of the country's immediate needs and to the abundance of water-power sites where power can be developed in small blocks at low costs. Such Canadian influence as is being asserted in favor of the St. Lawrence development is confined to the province of Ontario and the grain-producing provinces of western Canada which could take advantage of cheaper freight rates from the head of the lakes. Even in the provinces interested, the determination to secure the improvement is not sufficient to be regarded as of great political weight.

building demand at reasonable prices."

National Association of Building Trades Employers—"Your warning is very timely and should be given very careful consideration by all the component parts of business industry. One of the most serious dangers to the present revival of business activity seems to be the liklihood of manufacturers raising prices rather rapidly, due to the revival and encouraged further by the temporary shortage contributed to by the railroad and coal strikes. The tendency for us all to become opportunists, ready to take advantage of every condition, regardless of its effect upon the future, is a real menace to the permanent prosperity of our country, and your letter, therefore, seems particularly timely."

Concrete Mixer Association—"In spite of some increase in the cost of materials and labor, several of our members' companies have recently decreased the selling price of their product, which speaks for itself. You may rest assured that the concrete mixer industry will exert every possible effort to assist in stabilizing the construction industry."

Bates Road Tests Near Completion

With a load of 8,000 lb. on each rear truck-wheel, constituting the sixth load increment since tests were started, the day runs of traffic on the Bates experimental road were completed Aug. 11, according to a statement issued by the Illinois state highway department. Night traffic is now being sent over the road and 5,000 applications of the 8,000-lb wheel load will be made. This will conclude the traffic runs.

A survey of the sections at the end of the day runs with the sixth load increment showed only 11 of the 63 sections undamaged. Of these one consists of asphalt top on concrete base, one of bituminous-filled brick on concrete base and the other nine of concrete of various thicknesses and designs. In almost every section where failure occurred the breaks were located at the cut joints, progressive breaking developing from the original failure.

Under the 8,000-lb. load a total of 75 breaks occurred, of which 60 were on the south side where trucks were run along the pavement edge. Plans for building a few more sections of special design to be tested during the most unfavorable conditions in the late fall and spring are being considered.

McGraw-Hill Editor Is Attending Rio Engineering Congress

Verne Leroy Havens, editor of *Ingeniería Internacional*, the monthly technical journal in Spanish published by the McGraw-Hill Co., Inc., is in Rio de Janeiro, Brazil. He has been made the temporary chairman of the joint committee appointed by the four national engineering societies to consider and act upon all matters arising from the participation of those societies in the International Congress of Engineering, which opens Sept 17. Mr. Havens is also the official representative of the American Society of Civil Engineers at the engineering congress.

Upon the termination of the congress, Mr. Havens will visit Uruguay and Argentina on business.

Roads Suffer as Coal Strike Boosts Truck Traffic

One of the ways in which the people of the country are paying for the coal and railroad strikes, Thomas H. MacDonald, chief of the Bureau of Public Roads, points out, is in the deterioration of highways. Because of the strikes, he says, a greatly increased truck traffic has been forced on to the highways at a time when the roads are necessarily under-maintained. Under existing conditions there is a tendency to overload trucks and drive them at greater speeds. Due to the inability to secure materials, highway maintenance already is being accompanied by difficulties which necessarily will grow worse as the surplus of open-top cars is absorbed for coal transportation.

A careful survey of the situation east of the Mississippi River leads Mr. MacDonald to believe that a major disturbance in national highway progress is inevitable.

Ask Bids on Heavy Bascule

Bids are being called for Sept. 29 by the Harbor Department of Los Angeles, Calif., on the superstructure of a bascule bridge on Badger Ave., to connect Terminal Island with the mainland. It is to be a three-truss double-leaf bascule of the Strauss type, 220 ft. in span between trunnions, carrying two railway tracks, two roadways and a sidewalk. It will comprise 4,540,000 lb. structural steel, 147,200 lb. castings and forgings, 155,000 lb. machinery, and 77,000 lb. reinforcing steel. Trestle approaches at either end are to be built by the city. The work is part of a large port-development program, under which 7,000 lin.ft. of wharf and several transit sheds are now being constructed.

Muscle Shoals Gets More Money

Washington Correspondence

The President has authorized the transfer of certain river and harbor funds making available an additional $600,000 to apply on the work at Muscle Shoals. This sum insures the maximum amount of work which can be done on the project at this time and adequately bridges the period prior to Oct. 1 when the $7,500,000 appropriation becomes available.

The struggle in the House to secure consideration of the Ford offer continues. Representative Garrett, of Tennessee, the acting minority leader, forced the majority to abandon its plan for three-day recesses. He is forcing roll calls on adjournment and resorting to all parliamentary tactics to speed the disposition of other business before the House with the idea that the majority then will be compelled to proceed to the consideration of the Ford offer.

Representative Mondell, of Wyoming, the majority leader, states that he has no disposition to block the consideration of the matter but contends that the legislative situation is such that it would be perfectly idle to call up the matter at this time.

Coal Operators Hostile to Federal Price-Control

Legislators Resent Stand of Producers Who Would Divert Attention from Prices to Transportation

Washington Correspondence

While the coal operators have maneuvered themselves into a position where they must support, outwardly at least, the fact-finding legislation which has passed the House and is now before the Senate, it is very evident that their support is not whole-hearted. Their opposition to the price-control and distribution bill is particularly active.

There is feeling on Capitol Hill and among some of the executive officers of the administration that the course of the coal operators shows a lack of vision. They are moving toward a greater struggle in 1923 than they had in 1922. If prices are high this winter, they will enter the 1923 strike bereft of support from the public and in fact will have to contend with an embittered public opinion. For that reason some argue that they should recognize that this is an emergency and tender their honest advice as to the plan that distribution should follow to get the best results. In some quarters the attitude of the operators and the wholesalers is being referred to as typical of their inability to unite on anything other than a policy of opposition. This policy in the past has alienated many of their friends.

Operators' Viewpoint

The position of the operators is that the administration is making the same blunders as did the Wilson administration in 1917 when attention was centered on prices rather than on transportation. The drastic Weaver law, it is pointed out, resulted in only a few score of indictments for profiteering. The experience with that legislation, the operators contend, should be sufficient proof that prices cannot be regulated satisfactorily by law. It matters little if the price of coal be $1 a ton if it cannot be obtained. The situation was even worse in 1921, the operators point out, because there is much less coal above ground now, than was the case then. It can be said that the direct opposition to the control bill is not limited to operators and wholesalers of coal. A large number of consumers, particularly the larger ones, are objecting to the delegation of authority to the Interstate Commerce Commission which will allow that body to cut them off from their supply of coal. There is also opposition to the measure from senators who do not believe it good policy to vest such power in the federal government.

Very evidently the tactics of the opposition to the pending coal legislation will be to secure delay. Every day that final action can be deferred will diminish the pressure behind the legislation. At the rate coal will be distributed until the surplus of cars is exhausted will do much to allay public apprehension. The public will not realize that the spurt of production made possible by the surplus of cars cannot be maintained. As the legislation progresses there probably will be a demand on the part of the Pennsylvania senators for separate machinery to handle anthracite. This will tend to complicate the situation and make it easier to sidetrack the legislation.

Reclamation Amendment Is Included in Bonus Bill

McNary Proposal Incorporated in Adjusted Compensation Measure Passed by Senate

Washington Correspondence

Supported vigorously by senators from all sections of the country, the McNary reclamation amendment was added to the adjusted compensation bill, the so-called ex-service men's bonus bill, by a vote of 43 to 26 in the Senate last week. The amendment contemplates reclamation of arid and wet lands by irrigation and drainage with preference given veterans of the armed forces of the country, "World War, Spanish-American war and civil war," but not excluding the general public from settlement if all the land is not taken by veterans.

The amendment was opposed strongly by Senator McCumber, chairman of the finance committee and manager of the bonus bill, on the ground that its provisions jeopardized the bonus measure.

Senator McNary, of Oregon, advocating his admendment, pointed out that while it carries an authorization for $350,000,000, this amount remains to be appropriated and will not all come within any single year. The project is good not only for the former service men, but for the country generally, the Oregon senator declared. There are 22,458,000 acres of arid land and 96,090,000 acres of wet land subject to reclamation, Senator McNary said, most of this in the South and West, but some in New England and other sections.

McNary Plan Provisions

The McNary plan provides that upon application of a state to the Secretary of the Interior for formation of a reclamation district, the federal government shall make a survey. If feasible, a district must be formed, with property owners pledging 80 per cent of their holdings which shall be sold by the Secretary of the Interior on terms agreed upon in advance. Bonds to cover the cost of the project are to be issued by the district and sold through the farm land bank, the bonds to carry not more than 5 per cent interest and to mature in 40 years. The entire cost of the work is to be paid by the district. Farms are not to exceed 160 acres. The federal government will operate the reclamation system for one year, to test it, and then turn it over to the district. The cost of the survey is to be repaid by the district, if the project is accepted; otherwise the federal government will bear the cost, and this cost of rejected projects, and the cost of administration, according to the plan, are to be the only net costs to the federal government ultimately.

Veterans are to be given preference in the work attached to the projects, and are to have 60 days preference in the right to file applications for homesteads under any project.

The bonus bill itself as passed last Thursday by that body by a vote of 47 to 22, provides three options for those whose bonus credit would exceed $50. Payments of less than that sum would be cash. These are: first, certificates payable in 20 years or sooner in case of death, with certain loan privileges meanwhile; second, vocational training aid at the rate of $1.75 per day up to a total of 140 per cent of the bonus credit; and third, aid to purchase a farm or home, the amount to range from 100 to 140 per cent of the bonus credit, depending on how soon the payment be asked. Credit will be given on the basis of $1 per day for domestic service and $1.25 per day for foreign service, less the $60 paid at discharge. No credit will be given to exceed $500 for domestic service and $625 for foreign service. The face value of the bonus certificates would be 25 per cent greater than the amount of the credit but loan privileges would be based on the latter sum.

As the bill makes no appropriation and provides no means for raising the necessary funds it is expected that the President will veto the bill. Speculation is rife as to whether enough votes can be mustered to pass the bill over the President's veto, with the chances slightly against the bill's success.

The Engineer in Public Life

HERBERT A. WILSON

The Governor of Massachusetts has recently appointed an engineer, Herbert A. Wilson, as police commissioner of the City of Boston, adding to the ranks of engineers in public life. After graduation from the Brighton (Mass.) High School, in 1889, he spent seven months in the Boston City Surveyor's Office, on lines and grades for street construction. He was later promoted to the position of assistant in the central office of the Engineering Department of the City of Boston, principally upon the construction of bridges, wharves, and municipal engineering work of a miscellaneous character.

Mr. Wilson's engineering training did not get him into a rut nor dampen his political ambitions. He was elected to the House of Representatives of Massachusetts for the years of 1913-14-15-16, and to the State Senate in 1917 and 1918. In July 1918, Mayor Peters of Boston appointed him building commissioner, from which office he resigned in April of this year upon his appointment as police commissioner.

Mr. Wilson is a member of the Boston Society of Civil Engineers and the American Society of Civil Engineers.

To Consider Reciprocal Licensing

Reciprocal licensing of engineers will be considered by the Council of State Boards of Engineering Examiners which meets in Chicago on Oct. 2, 1922. This board consists of representatives from ten state boards, but it is expected that in some cases the entire state board will attend this meeting. An outline of the plan to be considered was published in *Engineering News-Record*, July 27, 1922, p. 156.

Indianapolis Seeks New Basis for Financing Resurfacing Costs

Methods of financing the cost of resurfacing improved city streets in Indianapolis, Ind., are being investigated by the Chamber of Commerce of that city, with the co-operation of the local chapter of the American Association of Engineers. The existing law, which it is desired to amend, places the entire cost of resurfacing upon abutting property owners. Information received as to the policies followed in 160 different cities shows that 70 cities do not assess the abutting property owner for resurfacing and that 93 assess some portion of the cost of resurfacing on the property benefitted. Of the 93 cities 60 assess more than two-thirds of the cost, while in the remainder of cases the assessment ranges from 25 to 50 per cent. Cities to the number of 39 follow the example of Indianapolis and assess the entire cost against the property owner.

For a number of years, according to a recent statement by the Chamber of Commerce, the problem of resurfacing improved streets had practically no significance because traffic was light and improved streets seemed destined to be long-lived. The theory behind the law which requires the abutting property owners to stand the entire cost of original improvement is that the property will be benefitted by the improvement to an extent commensurate with the cost of the improvement itself. However, such a theory, it is held, has no application to the law which now requiries the abutting property owners to pay for resurfacing costs, since the property receives no increased value as a result of the resurfacing. Because of the failure of the law now governing the assessment of resurfacing charges to stand on any sound economic theory, it is contended that the community, which wears out the pavement, and not the owners of abutting property, should bear all, or at least a part of the cost.

Adjustment of Land and Water Traffic Rights

Washington Correspondence

Questions were recently raised as to the practice of the War Department in adjusting the relative claims of land and water traffic at intersections between roads or railways and waterways. The following statement of the department attitude can be made: The corps of engineers has no hard and fast rule pertaining to superior right of way as between land and water traffic at bridges. The general policy is to prescribe regulations that will produce minimum inconvenience. Many draw bridges are not permitted to open during certain hours of the day, despite what is sometimes considered to be the paramount right of navigation. The highway bridge over the Potomac at Washington is not opened during the hours of peak movement of government employees to and from their work. The Harlem River Bridge in New York is opened only at certain hours, since it was raised to give a 24-ft. clearance height at high tide. Many boats can lower their smoke stacks and so arrange their upper gear as to make the frequent opening of draw bridges unnecessary.

Little Unemployment Among Professional Engineers

In a broad survey made by the employment department of the American Association of Engineers covering reports from more than 200 localities, little unemployment of professional engineers is found. Most sections are reporting a scarcity of men for engineering work that is in progress or positions that are available, particularly in the building field. Structural draftsmen, designers and architectural engineers have no difficulty in locating lucrative employment. The reported increases and adjustments to be made by the steel industry will in all probability affect engineering services. Such unemployment as exists is in certain manufacturing industries, and in the coal and railroad fields where labor trouble prevails. Apprehension is expressed from certain quarters of lessening construction activities and manufacturing due to car shortage, transportation difficulties and coal scarcity.

Considerable foreign work has been started or is anticipated by American firms who are and will be sending American engineers out of the country. Reports have been received from a number of members who have made connections to go to foreign countries. Practically all of the firms doing such work are in the East. Personal contact with these companies is the easiest means of effecting such a connection.

The following table shows the trend of employment covering all sections of the country and all work done by the association during June and July, 1922, as compared with July, 1921.

	July 1922	June 1922	July 1921
Applicants for employment	1484	1456	2215
Positions received	413	433	321
Men referred	1433	1462	2567
Men placed	206	225	212

In general the employment situation has taken a very decided turn for the better. This condition can be expected to continue for several months, or at least until the cold weather sets in, when construction activities slow down.

Oil Discharge Regulation Bill Passes Senate

A simplified bill to control the pollution of navigable waters, replacing a number of pending bills, was introduced in the U. S. Senate on Aug. 30 by Senator Frelinghuysen (New Jersey) and passed on the following day without debate and with no substantial change. The bill, which was endorsed as to general plan by Secretary of War Weeks and Maj.-Gen. Lansing H. Beach, Chief of Engineers, U. S. A., makes it unlawful to discharge oil—including fuel oil, sludge or refuse—upon, into or under navigable waters of the United States from any vessel, excepting for the purpose of smoothing the sea in case of emergency or under such regulations as may be prescribed by the Secretary of War in such quantities as shall not be deleterious to health or fish or dangerous to property. A fine of $2,500 for violation is provided and clearance papers may be denied until the fine is paid. The act does not become fully effective until three months after its passage and may be suspended in time of war.

U. S. Court Curbs Striking Shopmen by Drastic Injunction

On application of Attorney General Daugherty, Federal Judge Wilkerson of the U. S. District Court in Chicago has issued a temporary injunction against the striking shopmen, the officers and members of their unions and the affiliated unions of the American Federation of Labor, restraining them from interfering in any way with railroad operation. The writ is returnable on Sept. 11, when argument will be heard as to making the injunction permanent.

The restraint imposed on the strikers and their sympathizers is drastic and far-reaching. They are not to use the union funds in furtherance of any of the acts forbidden by the injunction. They are not to engage in picketing or in any way even by mail, telephone or through newspaper interviews, to persuade or encourage railroad workers to leave their positions. They are not to loiter about railroad property or to interfere with employees even to the extent of displaying force or numbers, jeering or taunting them. These restrictions are in addition to the usual restraint imposed upon actual interference with rail property and operation.

When the injunction was first announced organized labor through many spokesmen, including Samuel Gompers, displayed bitter resentment at its scope, and during the week-end there has developed a sentiment on all sides that the action is not calculated to achieve peace most speedily or on a basis of the greatest permanence. The railroad executives contend that conditions are not so desperate as to justify so drastic a step and fear that their efforts to resume normal operation may be set back rather than forwarded by the move.

Six Government Engineers Sail for Rio Engineering Congress

Washington Correspondence

When six of the Government's engineers were confronted with missing the opening of the International Congress of Engineers to be held at Rio in connection with the Brazilian International Exposition, the Federated American Engineering Societies intervened and was able to induce the State Department to allow these men to sail in time to be present at the opening session on Sept. 17. Among the number was Dr. T. T. Read, of the U. S. Bureau of Mines, who was one of the delegates designated by the Federation.

The State Department had postponed from Aug. 24 to Sept. 2 the date of sailing of the government engineers and scientists being sent to the exposition. Several efforts were made without success to secure the revocation of this order. The State Department's position was that the government would have to pay the subsistence expenses of these men for a longer period. The Federation, in a letter to Secretary Hughes, proposed to meet this expense insofar as Dr. Read was concerned so that their delegate could be present at the opening session. The offer was not accepted but Secretary Hughes asked that the order be rescinded and that all the members of the government party be allowed to sail as originally planned.

Site is Chosen for Bridge Across San Francisco Bay

Ravenswood Point, 33 Miles South of City, Recommended as Location for Proposed Highway Structure

Active interest in schemes for bridging San Francisco Bay, so far as immediate construction is concerned, has for some time centered on the selection of one of the proposed locations for a highway bridge across the lower end of the bay, with approaches suited particularly to automobile traffic. The two most promising locations have their western ends, respectively, at Ravenswood Point, 33 miles south of San Francisco by highway, or about 1½ miles above the present Southern Pacific R.R. bridge at Dumbarton, and at Little Coyote Point, which is 24 miles by highway south of San Francisco. In order to provide for traffic at either location, a new highway south from San Francisco is needed as present routes are already greatly overcrowded. The proposed new highway is to cost about $5,000,000 and is to be built 100 ft. wide in a 125-ft. right-of-way, the first construction being of a 40-ft. pavement with provision for future widening.

The California State Highway Commission considered both bridge sites and recommended the selection of the Ravenswood Point location as the "most direct, practical and economical." The Little Coyote Point location was rejected on account of the high cost of construction. The bridge from Ravenswood Point is estimated to cost $2,691,475 and would consist of eight 200-ft. fixed spans and one 310-ft. draw span; both approaches would be supported on concrete piles, the western approach being 1,768 ft. and the eastern approach, 1,734 ft. in length.

Joint committees are at work apportioning the cost of the new highway from San Francisco, the approaches, and the bridge itself among the state and the several counties and communities interested. With the highway commission definitely on record recommending location and type of bridge, it is not anticipated there will be delay due to any further discussion on these points. At a meeting of the joint bridge committee in San Francisco on Aug. 28 M. M. O'Shaughnessy, city engineer of San Francisco, stated that it would cost $50,000 to make the necessary surveys for the new highway from San Francisco to the bridge. Representatives of San Francisco and San Mateo counties, through which this road would run, assured the meeting that funds for this survey would be made available.

Contractor Sues Bridgeport

The Holbrook, Cabot & Rollins Corp., of Boston and New York, general contractors, last week instituted a suit against the City of Bridgeport, Conn., to recover $400,000 damages, alleging the city delayed them in performance of their contract in connection with the construction of the Stratford Avenue bridge in Bridgeport. The contract was entered into Oct. 5, 1915, and completed in 1920, at a cost of nearly $500,000. The contractors undertook the contract before prices of labor and materials had begun their big ascent due to war conditions, and at various times the increased costs made the contract a losing one for the builders.

Hearings on Hydraulic Laboratory Bill to Begin Soon

Washington Correspondence

Hearings on the bill proposing that the federal government establish a national hydraulic laboratory, will begin Sept. 8 before a sub-committee of the Senate Committee on Commerce of which Senator Ransdell is chairman. John R. Freeman, president of the American Society of Civil Engineers, will appear before the Committee at that time. The hearings will be reconvened each day until he has completed his presentation of the need for such a laboratory. It then is the intention to allow an interim of several weeks before the next hearing is had so as to give an opportunity to circulate the printed copies of Mr. Freeman's testimony. Witnesses who are properly qualified to criticise or make suggestions in connection with Mr. Freeman's plan then will be called.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Annual Convention, New Bedford, Mass., Sept. 12-15.

AMERICAN ASSOCIATION OF PORT AUTHORITIES; Montreal, Que.; Annual Convention, Toronto, Ont., Sept. 14-16.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburg, Fla.; Annual Convention, Cleveland, Ohio, Oct. 2-6.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Fall Meeting, San Francisco, Oct. 4-9.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York; Annual Convention, Cleveland, Oct. 16-19.

The Indianapolis Chapter of the American Association of Engineers at its meeting Aug. 24 took up the question of salaries for public service engineers. The A. A. E. chairman of the national committee on salaries of engineers in public service started the discussion which had in mind the securing of sufficient data upon which the national committee might base some action.

Personal Notes

HENRY E. ELROD, consulting engineer, Dallas, Texas, has returned to his home in Santa Monica, Cal., where he is located for the present regaining his health. He expects to return to Texas soon to resume his practice.

B. H. DUDLEY, former office manager of the P. J. Leevelling Construction Co., has become associated with M. Hayes & Sons, general contracting firm of Dongola, Ill. Mr. Dudley's new position is also office manager.

THOMAS R. CAMP, at one time a resident engineer and later city engineer of Breckenridge, Texas, has joined the consulting engineering firm of Hawley & Sands, of Ft. Worth and Houston.

D. L. COSTELLO, formerly an inspector of construction in the U. S. Navy construction department, has been made a resident engineer in the Massachusetts Bureau of Highways, Department of Public Works. He is stationed at South Egremont, Mass.

MCCLENDON & PURNELL, Mineral Wells, Texas, have been appointed engineers for Bosier Parish, La., where $1,000,000 will be spent on flood control.

CLIFFORD R. ALLEE, former construction foreman for the Indiana Oil Refining Co., has become associated with the Port Jervis (N. J.) Waterworks Co. as superintendent in municipal water supply construction.

IVAN M. DANSARD, former assistant in civil engineering at Purdue University, has joined the staff of the Fargo Engineering Co., Jackson, Mich.

R. E. KILLMER, recent assistant county engineer of Bexas County, Texas, has been appointed county engineer, vice C. E. HOFF who has resigned to engage in road contracting work.

T. H. WEBB testing engineer, has been appointed assistant state highway engineer of Texas to succeed CHARLES H. KENDALL who has resigned. R. J. HANKS will succeed Mr. Webb as testing engineer.

ARTHUR P. PATTERSON has been appointed county engineer of Coffey County, Kansas, to fill the vacancy caused by the resignation of B. S. COHN. Mr. Patterson was formerly employed by the Portland Cement Association at Milwaukee, Wis.

E. H. COTTRELL, consulting engineer of Dallas, Texas, was recently appointed city engineer of McKinney to succeed CHARLES SCHULTZ who has resigned to become city engineer of Tulsa, Okla.

CAPT. HENRY C. PORTER has been appointed a Texas state highway division engineer to succeed JAMES PERIE who resigned to become city engineer of Ballinger, Texas. Capt. Porter was until recently county engineer of Kleberg County.

EDWARD SVANOE, a widely-known Norwegian hydro-electric engineer, will arrive in the United States Sept. 16 to attend the San Francisco meeting of the American Society of Civil Engineers. O. C. Merrill, the executive secretary of the Federal Power Commission, is arranging an itinerary for Mr. Svanoe, which will allow him to visit some of the larger hydro-electric developments in this country prior to the opening of the meeting on Oct. 4.

JOHN E. BLAIR until recently a resident engineer, Texas State Highway Department, is now city engineer of Mineola, Texas.

CALVIN E. COCK, of Temple, Texas, has been appointed county engineer of Neches County, Texas, with headquarters at Corpus Christi.

R. D. MORGAN, who has been city engineer of Temple, Texas, fo a number of years has resigned to become superintendent of water and sewers at Mexia, Texas.

BLAINE POTTER, Superintendent of Public Works for Jamestown, N. Y., has resigned. The office which he has occupied will be consolidated with that of the city engineer.

FAY, SPOFFORD & THORNDIKE, consulting engineers of Boston, have announced that they have admitted to partnership the following men: JOHN AYER, BION A. BOWMAN, CARROLL A. FARWELL, RALPH W. HORNE, RALPH T. JACKSON, GEORGE L. MIRICK, BARZILLAI A. RICH, and WARREN D. TRASK. Most of these men have been long associated with the firm. The business is to be continued as heretofore under the existing firm name.

WILLIAM A. DOERRIES, at one time assistant engineer of Elizabeth, N. J., and previous to that time assistant chief engineer on the construction of the Bayway refinery of the Standard Oil Co. of N. J., is now associated with the Ozark Engineering Co., Springdale, Ark., engineers, as chief engineer. The organization with which Mr. Doerries is associated is engaged in considerable road construction work in the Ozark Mountains.

BOYD A. BENNETT, recently elected city manager of Charlottesville, N. C., after having been director of public works for Lynchburg, Va., assumed his new duties Sept. 1. Mr. Bennett has been acting city manager of Lynchburg during the absence of E. A. BECK, city manager, on vacation.

COL. C. H. CRAWFORD, the South American manager of the Baldwin Locomotive Co., and CLIFFORD SHOEMAKER, of Washington, D. C., have been appointed official representatives of the American Association of Engineers to attend and report upon the International Engineering Congress being held at Rio de Janeiro in connection with the Brazilian Centennial Exposition. The congress opens Sept. 17.

Business Notes

R. E. BROOKS CO., New York City, has taken over the sale of industrial barrows manufactured by the Akron Barrow Co. The company will act as exclusive selling agents in greater New York.

THE AUTOMATIC FLUSH TANK CO., Cedar Rapids, Iowa, has taken over the business of the DE LA HUNT FLUSH TANK CO., including late improvements in siphonic and air-locking devices for intermittent flooding of sand filters, and announces that the organization and plant facilities have been enlarged and improved considerably.

THOMPSON & MATTHEWS CO. INC., general contractors, of Red Bank, N. J., wish to announce that the firm name has been changed to S. S. THOMPSON & CO. INC.

L. R. TILLOTSON has been appointed sales representative for the Barrett Co., New York, in Kansas. He

will be connected with the Kansas City, Mo., office with headquarters in Topeka, and his attention will be directed towards rural highway work.

THE UNITED PAVING & CONSTRUCTION CO., LTD., Victoria, B. C., has been organized recently and has undertaken a street-paving project for the city of Victoria to cost approximately $200,000 and consist of about ten miles of asphalt penetration road. D. W. Johnston of Vancouver, who has been identified with a number of western municipalities in engineering work during the last fifteen years, is the chief engineer of the newly-organized company.

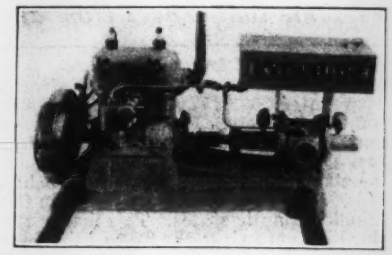
FRANK E. RANSOME, until recently with the Fegles Construction Co., Ltd., Minneapolis, as construction superintendent on the recently completed Barge Canal grain elevator at the Erie Basin, Brooklyn, N. Y., has purchased an interest in the Lynch Construction Co., New York City, and will serve as construction superintendent for that organization on a $2,000,000 warehouse for the Standard Milling Co., Jersey City, N. J. Mr. Ransome's past experience includes connections with Twohy Bros., contractors, Portland, Ore., the Security Bridge Co., Minneapolis, and the Turner Construction Co., New York City.

THE MCWANE CAST IRON PIPE CO., through its president, J. R. McWane, has announced that a new plant will be built on a 30-acre tract in Birmingham, Ala., to take care of future expansion. The first unit will be started at once and is expected to be in operation by March 1, 1923. The new plant will specialize for the present on the smaller sizes of cast-iron pipe, particularly the newly-developed 2-in. and 1¼-in. sizes, claimed to be the smallest cast-iron pipe now made. It will turn out approximately 8,000 ft. of pipe per day and will start with a force of 150 men. The company is comparatively new, having been organized early this year, but Mr. McWane has been in the cast-iron pipe business for years and was one of the organizers and, later, president of the American Cast Iron Pipe Co., also of Birmingham. From this same company James D. Sample, assistant to the president, resigned to become vice-president of the McWane company. One of the chief products of the new company will be the McWane precalked-joint, cast-iron pipe, described in another column of this issue.

EQUIPMENT AND MATERIALS

Portable High-Pressure Pump

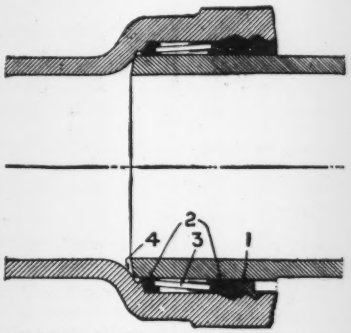
A light portable, high-pressure pump designed primarily for use in putting out forest fires, but adapted, also, according to its manufacturer, the Evinrude Motor Co., of Milwaukee, to a variety of construction uses, has been placed upon the market. The equipment, illustrated herewith, weighs less than 100 lb. complete and has a capacity of 2,400 gal. an hour under 70-lb. pressure, and 900 gal. an hour at 155-lb. pressure. The pump is a small Viking special internal gear pump, direct-connected to an Evinrude 4-5 hp. two-cylinder, two-cycle motor, with magneto built into



the flywheel. The overall length is 31 in., the width 11½ in., and the height 17 in.

Precalked Joint for Cast-Iron Pipe

A precalked joint for cast-iron pipe, the result of 8 years of research, has been developed by the McWane Cast Iron Pipe Co., of Birmingham, Ala. The joint is practically factory-made and eliminates the need for the bell hole in laying. In manufacturing it the pipe is stood vertically in racks, bell end upward. A mandrel imperceptibly larger than the spigot end of the pipe it represents is inserted in the joint. Then braided hemp packing, a specially-prepared ring of closeset iron wedges, two more braids of hemp and a final filling



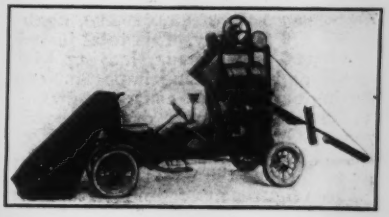
1, Lead; 2, Hemp; 3, Iron Wedge; 4, Shoulder of Pipe.

of lead are placed in the joint. Pneumatic calking tools calk the joint thoroughly for one-half its circumference.

In laying this pipe it is only necessary to knock out the protecting wooden blocks, place the pipe with the precalked side downward in the trench, and calk on top. Driving the lead in thus at the top forces the pipe down firmly to a seat at the bottom. A little touching up of the bottom side of the joint with double offset tools completes it.

Small Mixer Mounted on Ford Truck

A 7-cu.ft. paving and building mixer, mounted on a Ford truck chassis, has been placed on the market by the Archer Iron Works, Chicago. The full power of the Ford engine is available for the operation of the mixer, which can be controlled by one man either from the driver's seat or from the ground. The short wheelbase is pointed out as an advantage for the road contractor's use. The machine is equipped with a loader, automatic water tank and a 9-ft. distribution chute with gate openings. The mixer frame is clamped to the chassis with U-bolts allowing



contractors to adopt it to their own Ford trucks if desired. The weight of the outfit, complete with loader, is 2,500 lb.

Advantages are claimed for this equipment as a building mixer, especially where work is spread over a large area, requiring frequent movement from one location to another.

The Archer-Ford mixer is also furnished as a low-charging mixer with drum set directly on the truck chassis and equipped with loading platform for charging materials into the drum direct from wheel barrows. In this type the loader, water tank and paving chute are not provided.

Out-of-the-Ordinary Trade Publications

Synchronous Motors—THE ALLIS-CHALMERS MFG. CO. has issued a new bulletin 20 pp., illustrated, dealing largely with industrial uses of synchronous motors for belted, coupled or direct-connected service.

Wave Transmission of Power—Walter Haddon, 132 Salisbury Square, Fleet St., London, E. C. 4, England, has issued a 56-p. illustrated booklet describing his patented method of power transmission by wave vibrations and the storage of energy in liquids. Applications of the system to rock drilling and other industrial uses, such as riveting and calking, are illustrated. In the wave-transmission method, the discovery of Gogu Constantinesco, water is contained in a system of flexible-jointed piping connecting apparatus which generates wave motions with the drill or other machine which applies the power created. Power is derived not from a direct flow of water, but rather by a series of pulsations backward and forward. The wave generator consists of one or more cylinders with pistons driven by steam or gasoline engine or electric motor. Drilling equipment utilizing the wave transmission principle is manufactured by W. H. Dorman & Co., Ltd., Stafford, England.

Business Side of Construction

Facts and Events that Affect Cost and Volume

August Contracts Show Gain Over Preceding Month

Average Weekly Rate of $32,026,000, Against $29,793,476 During July Heavier Than August, 1921.

August contracts, as announced in the five August issues of *Engineering News-Record*, aggregated $160,130,000, compared with $119,173,906 reported in the four July issues. This is an average weekly rate of $32,026,000, against $29,793,476 for July. This total includes $12,542,000 for Canada, leaving $147,588,000 as representing important engineering-construction contracts awarded in the United States during the five weeks. The rate for August, 1921, was $26,161,000 per week, which is about 20 per cent lower than this year.

These figures are compiled from Construction News and involve large engineering projects only, with a minimum of $25,000 on public works, except water-works, ($15,000), $40,000 for industrial construction and $150,000 for commercial buildings.

The most notable gains were in industrial lettings and building awards. Industrials reached a total of $21,660,000 during the five weeks of August as against $11,616,000 during the four weeks of July. Buildings totaled $73,512,000 as compared with $50,834,000 for July. Streets and roads contracts aggregated $37,035,000 as against $33,536,000 for July. Federal Government contracts totaled $1,547,000 for August as compared with $7,099,906 in July.

Lettings in the Middle West reached $46,004,000 as against $44,756,000 in the Middle Atlantic states. This makes the third instance since the first of the year in which the Middle West has surpassed the Middle Atlantic states in the total values of contracts awarded.

Finance Briefs

Stock market strong.

Bond market irregular, with few new issues. Appointment of a receiver for the Chicago & Alton weakened the more speculative railway bonds. Industrials dull. Discussing foreign government obligations the Annalist says: "Evidently the decision to allow a six months' moratorium, with present payments made in short-term German Government Treasury Notes, was regarded as constructive, for prices for securities of the Governments most interested were strong at the close."

Money—Resources of the national banks of the United States amount to $20,706,000,000 on June 30, which was $529,000,000 more than on May 5 and $188,000,000 over June 30, 1921.

Higher Fuel, Labor and Sacks Advance Cement Prices

In a letter from Mr. C. B. Rogers, sales manager of the Sandusky Cement Co., Cleveland. Ohio, recently sent to retail dealers in the distributing territory of Indiana, Illinois, Iowa, Michigan, Ohio and Wisconsin, the cost of coal and its effect upon cement prices are very forcibly illustrated.

The price of coal per ton, f.o.b. the Bay Ridge, Ohio and Dixon, Ill. mills, during the first four months of 1922, was $4.02. During the months of May and June the price rose to $4.85 and between July 1 and 15, another advance brought the figure to $9.64. The cost of fuel reached $10.64 per ton between July 16 and 31.

Commenting upon the situation, Mr. Roger's letter is quoted in part:

"It takes 200 lb. of coal to burn one barrel of cement. Therefore, every $1.00 per ton on cost of coal equals 10c. per barrel on cost of finished cement.

"It is readily seen that the one item of coal entering into the cost of manufacturing a barrel of cement shows an increase of 66c. per barrel during the last fifteen days of July over the first four months of the current year, and no immediate prospects of relief.

"The first four months of this year

Engineering News-Record Construction Cost Index Number

September, 1922	185.00
August, 1922	173.40
September, 1921	188.27
Peak, June, 1920	273.80
1913	100.00

Engineering News-Record's Construction Cost Index Number is 12 points higher than last month, due to continued stiffening in prices of steel and lumber, and advance in cement and labor. Steel is now $1.90@$2.25, Pittsburgh mill. Lumber and cement advanced generally. Common labor stiffened in three important centers, resulting in an average rate for the entire country of 45c. Thus, general construction cost is only 2 per cent cheaper than one year ago and 32 per cent under the peak; it is 85 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly	
August, 1922	154
July, 1922	118
August, 1921	94
1913	100
Yearly	
1921 (entire year)	88
1920 (entire year)	91
1913	100

Engineering News-Record's Construction Volume Index Number is 154 for the month of August, and 88 for the whole of 1921, as against 100 for 1913. This means that the actual volume of construction in 1921 (not the mere money value of the contracts let that year) is 12 per cent under the volume of construction for 1913. Our monthly volume number, 154 for August, 1922, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA IN AUGUST, 1922

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	Western	Canada	Total
Waterworks	.....	$2,193,000	$312,000	$873,000	$677,000	$232,000	$207,000	$4,494,000
Sewers	$104,000	408,000	568,000	1,577,000	463,000	76,000	254,000	3,450,000
Bridges	151,000	516,000	997,000	810,000	485,000	731,000	1,481,000	5,171,000
Excav. and dredging	.....	19,000	6,600,000	123,000	128,000	50,000	.....	6,920,000
Streets and roads	1,041,000	6,343,000	6,568,000	12,157,000	6,044,000	2,542,000	2,340,000	37,035,000
Industrial works	2,040,000	7,155,000	519,000	6,408,000	2,050,000	576,000	2,912,000	21,660,000
Buildings	3,197,000	26,488,000	1,098,000	23,729,000	8,622,000	7,153,000	3,225,000	73,512,000
Fed. Gov't work	166,000	269,000	887,000	17,000	11,000	197,000	.....	1,547,000
Miscellaneous	180,000	1,365,000	883,000	310,000	189,000	1,291,000	2,123,000	6,341,000
Total	$6,879,000	$44,756,000	$18,432,000	$46,004,000	$18,669,000	$12,848,008	$12,542,000	$160,130,000

we secured all needed common labor at 25c. to 28c. per hour. Today we are paying for same class of labor 35c. per hour or an increase of 25%. All semi-skilled and skilled labor in like proportion.

"During the winter of 1921-22 cement sacks could be purchased at 9½ and 10c. each; today the cost is 16c., an increase of 6c per sack or $6,000 per car. We still charge you but 10c. for each sack. We purchased our last car of 100,000 sacks on June 28, 1922. We have purchased 500,000 sacks since January 1st. This last purchase was made due to Medusa Sacks not being returned as promptly as might be, nor in proportion to increased shipments due to heavy storage on part of contractors.

"These are but three items that enter into the cost of producing a barrel of finished cement. The above figures are accurate as applying to Medusa Cement.

"Permit us to ask: would you raise your price if you were in our position?

"In addition to above, our 'Annual Jinx' is now on our heels—'Car Shortage.' For two successive days, we have received no cars in which to ship orders."

Bad Order Cars Decrease 9,438 In Twenty-four Days

Reports received from the railroads of the United States by the American Railway Association, show that out of the 2,267,399 freight cars on all lines, 335,575 or 14.8 per cent, were in need

Labor Rates and Conditions Throughout the Country

With the strike in the bituminous mines nearly over, save for a few thousand men still out in the non-union fields of Pennsylvania and the union districts of West Virginia, and settlement with the anthracite miners practically effected, soft coal production reached a total of nearly 9,700,000 tons for the week ending Sept. 2, according to the Geological Survey.

Now comes the complaint of a car shortage, the limiting factor in the production of bituminous coal, from the union districts of Eastern Ohio and Northern West Virginia. With the soft coal output, for the week in question, over 25 per cent above the country's normal weekly consumption for that period, a car shortage rather than an insufficient fuel supply becomes the principal check to normal industrial progress. With the supply of fuel increased, greater activity is also noted in steel operations. Miners temporarily employed in the steel works, will presumably return to the coal fields, now that the old wage rate has been definitely maintained. That, together with restricted immigration and several other factors tending toward a scarcity of labor in the steel mills, is responsible for the notable advance of 20 per cent in the wages of common labor in the steel industry, effective Sept. 1.

Following the wage gains realized by coal miners and steel workers come announcements of advances in common labor rates, in the construction industry, from three cities reporting to *Engineering News-Record*. All three quote a minimum of 30c.@35c. per hr. as against a rate of 30c. in Atlanta, 25c.@30c. in Montreal and 25c.@35c. per hr. in Philadelphia, previously. Bricklayers in Philadelphia have been granted $1.20 as against $1 per hr. and hoisting engineers in Kansas City, $1@$1.25 as compared with $1 per hr., last month. No reductions have occured in the building trades' wage schedule, throughout the country, during the month.

Local labor conditions as reported by *News-Record* correspondents are given as follows:

Seattle — Lumber mills operating within 2 per cent of normal and logging camps running full blast. Volume of new construction holding up and expected to continue into the early winter. Demand for harvest hands absorbing all unemployed.

Detroit—All classes of labor a little more plentiful than a month ago, due to slackening of construction. Men on city work threatened with lay-off because of lack of cement. Bonuses being paid to bricklayers.

Birmingham — Construction less active. Wage increase of 20 per cent granted steel workers and coal miners.

Philadelphia—Scarcity of bricklayers, hodcarriers, carpenters and hoisting engineers. Fair supply of piledrivers and structural ironworkers. Plenty of common laborers, but men are paid off each night and new ones hired next day.

Kansas City—Scarcity of bricklayers and carpenters. Plenty of all other crafts. Union common laborers receive 60c. per hr.

Pittsburgh — Carpenters and bricklayers scarce; plenty of hodcarriers and common laborers and a sufficient number of hoisting engineers and structural iron workers. Wage advance of 20 per cent in steel mills, effective Sept. 1.

Montreal — Scarcity of bricklayers; ample supply of other trades.

San Francisco—Still plenty of work for all classes of construction labor.

New Orleans—No complaint on the part of contractors of a shortage of skilled or unskilled labor.

Denver—Building trades mechanics, 100 per cent employed.

New York—No change in skilled building trades' wage rates since 1921. Common labor average still between 44c. and 60c. per hr. Pick and shovel men in excavation work, however, receive as low as 40c. per hr., non-union. In building construction common laborers receive not less than 50c. with the union minimum rate at 60c. per hr.

(Higher rates indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90	$0.70	$0.70	$0.30	.....	$0.65	+$0.30@.35
Baltimore	1.25	.80	.87	.54	$0.74	1.00	.30
Birmingham	1.00	.75	.50@1.00	.15@.25	.....	1.00	.15@.20
Boston	.90	.90	.90	.60	.90	.90	55
Cincinnati	1.25	.95	.95	.72½	.77½	.95	.40
Chicago	1.10	1.00	1.10	.....	1.10	1.05	.72½
Cleveland	1.25	1.04@1.10	1.04	.60	.91	1.10	.57½
Dallas	1.00	1.00	1.00	.60	1.00	1.00	.25
Denver	1.25	1.00	1.00	.75@.81½	1.00	1.03½	.35@.50
Detroit	1.12½	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	1.07½	1.00	+1.00@1.25	.80	.85@1.00	1.07½	.60
Los Angeles	1.25	1.00	1.00	1.12½	87½	1.00	.56½@.62½
Minneapolis	1.00	.80	.80	.65	.....	.80	.35@.50
Montreal	.90	.65	.50	.35	.50	.55	+.30@.35
New Orleans	1.00	.85	.90	.50	.80	1.00	.35@.40
New York	1.25	1.12½	1.25	.87½	1.00	1.12½	.44@.60
Pittsburgh	1.30	1.12½	1.00	.80	1.00	1.00	.50@.60
St. Louis	1.25	1.12½	1.12½	.85	1.00	1.05	.35@.40
San Francisco	1.12½	1.00	1.00	.75	1.00	1.12½	.47½@.50
Seattle	1.00	.80	.90	.70	1.00	.80@.90	.50@.60
Philadelphia	+1.20	.90	.90	.75@90	1.00	.90	+.30@.35

of repairs on Aug. 15. This was an increase of 10,992 cars over the total number in bad order on July 1, when the shopmen's strike began, at which time there were 324,583 cars or 14.3 per cent.

Between Aug. 1 and Aug. 25, however, freight cars in need of repairs decreased 9,438, according to reports of the Association of Railway Executives, issued Sept. 2.

Surplus cars, in good repair and ready for immediate use if necessary, totaled 140,253 on Aug. 15. This represents a decrease of 13,627 cars since Aug. 8. Of the total, 10,453 were surplus box-cars, a reduction of 5,420 within a week; while 111 521 were surplus coal cars which was a decrease of 6,523 within the same period. Surplus coke cars totaled 3,620, a decrease of 262 since Aug. 8.

Coal loadings on Thursday, Aug. 31, totaled 29,027 cars. Although this was an increase of 816 cars over the preceding day, it was also 1,027 cars fewer than were loaded on Monday, Aug 28, when the total was 30,054 cars, the largest number loaded on any single day since Apr l 1, when the miners' strike began.

Increases in coal loadings were reported in the Allegheny, Northwestern, Centralwestern, and Southwestern districts, with small decreases in the others.

Lumber Industry Looking for Cars

The lumber industry throughout the country is looking for cars to make shipments and hoping that embargoes may soon be lifted. For the week ending Aug. 19 reports of the various associations to the National Lumber Manufacturers Association indicated a slight drop in production, shipments of only 88 per cent of the cut, but orders were 95 per cent of the cut. It is evident that many mills are turning down orders and thus restricting new business on account of their inability to ship much stock already cut and dry, according to A. Fletcher Marsh, statistician of the association.

Among the individual associations the volume of southern pine new bookings continue high although shipments are 20 per cent less than new business and some of the mills east of the Mississippi are still shipping nothing. On the Pacific Coast, the West Coast Lumbermen's Association shows a production at the same level as for the previous week, with shipments picking up somewhat, but orders are being refused by the mills.

Reports received, Aug. 31, by telegraph from all the regional softwood lumber manufacturing associations of the country, reflect the cumulative effects of the coal and railway strikes which are expected to continue to influence the lumber movement for some time after their settlement. Orders for lumber show a noticeable decrease from those of the previous week, production also fell off and shipments barely held their own. Nevertheless the lumber industry continues to hold a decided margin of increased activity over this time last year.

With respect to the normal production for the week ending August 26 of the five larger associations, that being 214 594,097 feet, the actual cut was 100 per cent, shipments 88 per cent and orders 92 per cent. For all the eight regional associations reporting weekly, shipments were 89 and orders 91 per cent of production.

Total production for the week by 375 mills was 236,485,952 feet; shipments, 210,551,595; orders, 214,778,959; the respective decreases being, 4,722,445 feet, 369,423 and 13,204,602, from the figures of the 388 mills reporting the preceding week. As compared with the corresponding week of 1921 production advanced by 61,294,848 feet, shipments by 37,539,042 and orders by 27,817,992. These advances do not maintain the margin of increase for the year as a whole, or come up to expectations for August as based on the usual ratio of that to other months.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron — Continued scarcity has advanced price of No. 2 foundry, $6 in Cincinnati and Chicago, $7 in Birmingham, and $8 in Pittsburgh, during the last month. Basic iron up $1 in Pittsburgh, $2 in Cincinnati and $5 in Philadelphia; bessemer, $5 per gross ton higher, in Pittsburgh.

Railway Supplies—Light rails up $3 per ton in Pittsburgh. Standard spikes advanced 10c.@15c. and track bolts 25c. per 100 lb., at mill.

Pipe—Discounts reduced three points on black steel, two on galvanized, and five on both black and galvanized iron pipe, on new Pittsburgh basing card of Aug. 23. Similar reductions in warehouses throughout the country. Pig-iron scarcity, consequent to recent fuel shortage, reflected in higher cast-iron pipe quotations. Rise of 50c. in Birmingham, $1.46 in Chicago and $2 per ton, on 6-in. pipe, in New York. Clay drain tile, 4-in., up $3 and 8-in., $10 per 1,000 lin-ft., in New York. Sewer pipe, together with most other clay products affected by fuel situation; rise of 1c.@4c. per ft. on smaller sizes at Pittsburgh, followed by similar advances in Detroit, Philadelphia and New Orleans.

Road and Paving Materials—Road oils up ½c. per gal. in New York. Bulk asphalt advanced $1 in New York, Baltimore and Atlanta; $2 in Boston and Philadelphia and $4.50 per ton in Detroit. Asphalt in packages up $1 in Boston and $3.50 per ton in Detroit. Rise in road oils and asphalt due to abrupt falling off in Mexico petroleum output since striking salt water at principal production centers. Granite paving blocks, 5-in., up $3 in Philadelphia and $3.25 per M in New York. Wood paving blocks, 3½-in., advanced 12c. in New York, 12½c. in New Orleans and 15c. per sq.yd. in Boston; due to higher lumber and labor costs. Philadelphia, however, quotes reduction of 24c. per sq.yd.

Sand Gravel and Crushed Stone—Sand and gravel quoted at $2 as against $1.80 per cu.yd. in Chicago, and at $1 as compared with $1.25, one month ago, in Seattle. Minneapolis quotes advance of 25c. and Philadelphia, 5c. per cu.yd. on both ¾-in. and 1½-in. gravel. Price fluctuations due to purely local conditions.

Lime—Advance of $2 per ton on both lump and hydrated in Philadelphia. Lump finishing quoted at $2.40 as against $1.75 per bbl. (180 lb. net) in New Orleans. Hydrated finishing down 50c. per ton and common lump 5c. per bbl. in Atlanta. Reductions due to falling off in demand.

Cement—Mill advances, due to fuel situation, of 10c. at Hudson, N. Y., Mason City, Ia., and Northampton, Pa.; 15c. at Buffington, Ind., Universal, Pa., Fordwick, Va., and Leeds, Ala., and 5c. per bbl. at Hannibal, Mo., effective during the last month. Mill rise reflected in following advances: f.o.b. Philadelphia, 10c.; Chicago, Pittsburgh, Cleveland, Detroit, Indianapolis, Milwaukee, Peoria, Cedar Rapids and Davenport, 15c.; New York, Cincinnati and Toledo, 20c. per bbl.

Structural Steel—Wage advance of 20 per cent plus increased fuel costs, reflected in higher steel quotations both at mills and warehouses. Minimum of $1.90 on steel shapes established by leading interest; independents, generally, quoting $4@$5 per ton, higher. Maximum of $2@$2.25 per 100 lb., f.o.b. Pittsburgh, on shapes and bars, has applied on actual sales during week.

Shapes and plates up 15c. in San Francisco, 20c. in Dallas, 21c. in New York and 24½c. per 100 lb. in Chicago warehouses, during month. Reinforcing bars advanced 21c. in New York, 22½c. in Chicago and 45c. in San Francisco. Rivets, ¾-in., up 25c. at mill; 15c. in New York, 25c. in Chicago and 50c. per 100 lb. in Dallas warehouses.

Steel Sheet—Rise of 10c.@20c. per 100 lb., f.o.b. Pittsburgh. Blue annealed up 25c.; black, 40c. and galvanized 50c. in Chicago warehouses, during month. Advance of 25c. per 100 lb. in New York.

Brick and Hollow Tile—Common brick quoted at $18@$20 as against $20 per M, alongside dock, New York. Slight falling off in demand. Dallas reports reduction of 25c. per M., in month. New Orleans, however, quotes advance of 50c., Mineapolis, $1 and Cleveland, $2 per M. Hollow tile continues to rise. Slight advance in Denver, Cleveland, Mineapolis and Philadelphia.

Lumber — Despite prevailing transportation difficulties, lumber demand is very strong. Sharp advances reported in New York, Chicago, Mnneapolis, Birmingham, Philadelphia, Detroit and Montreal.

Scrap—Pig-iron shortage causing increased demand for iron and steel scrap. Average advance of $1 per gross ton on all grades, in New York.

Explosives — Market stable; slight advance in Birmingham on 40@60 per cent gelatin dynamite.

Linseed Oil—Prices firm throughout country. Chicago, however, reports drop of 2c. per gal. during month; slight reduction in Minneapolis.

Price advances since last month are indicated by heavy type; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	**$25.05†**	**$24.50**
Northern Basic	**28.27†**	21.52
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	**32.27†**	22.52
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	**32.44†**	30.26
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@ 2.75)	**27.00†**	20.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@2.75 sil.)	**33.64†**	21.76
Virginia No. 2 (silicon 2.25 @ 2.75)	**31.17†**	28.74*
Basic	**31.14†**	20.26†
Grey Forge	**31.50†**	22.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@ 2.25)	**30.00†**	20.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	**28.00†**	26.66
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	**33.00†**	21.96
Basic	**26.00†**	19.96
Bessemer	**30.00†**	21.96

***F.o.b. furnace. † Delivered.**

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh			
	Current	One Year Ago	Birmingham	Chicago
Standard bessemer rails	$40.00	$45.00	.....	$40.00
Standard openhearth rails	40.00	47.00	$40.00	40.00
Light rails, 8 to 10 lb	**38.00**	45.00	1.70*	1.60@1.70*
Light rails, 12 to 14 lb	**38.00**	45.00	1.70*	1.60@1.70*
Light rails, 25 to 45 lb	**38@40**	40.00	1.70*	1.60@1.70*
Rerolled Rails	**24@29.50**	.....	.....	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.35	**$1.50**
Chicago, Hardwood and Red Oak	1.20	**1.30**
Chicago....Empty Cell Creosoting (add'l)	.45	**.50**
San Francisco..... Green Douglas Fir	.85	**1.10**
San Francisco, Empty Cell Creosoted, Douglas Fir	1.86	**2.30**
St. Louis, White Oak*	1.10	**1.44**
St. Louis, Red Oak*	.97	**1.17**
St. Louis (creosoted)	No. 1, $0.86;	No. 2, $0.96; No. 4, $1.28

*Standard specifications 38c. per tie additional. Zinc chloride process 27c. per tie additional.

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Current	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅜-in. and larger	$2.35@2.50	$3.00	$2.55	$3.00	$4.10	$2.80
Track bolts	**3.25@3.50**	4.00	3.65	4.25	5.10	3.80
Standard section angle bars	2.40	2.75	2.40	3.00	4.00	3.00

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	**68**	**56½**	⅛ to 1¼	**39½**	**24½**

LAP WELD

2	**61**	**49½**	2	**34½**	**20½**
2½ to 6	**65**	**53½**	2½ to 4	**37½**	**24½**
2 to 8	**62**	**49½**	4½ to 6	**37½**	**24½**
9 to 12	**61**	**48½**	7 to 12	**35½**	**22½**

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1¼	**66**	**55½**	⅛ to 1¼	**39½**	**25½**
2 to 3	**67**	**56½**			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	**59**	**48½**	2	**35½**	**22½**
2½ to 4	**63**	**52½**	2½ to 4	**38½**	**25½**
4½ to 6	**62**	**51½**	4½ to 6	**37½**	**25½**
7 to 8	**58**	**45½**	7 to 8	**30½**	**18½**
9 to 12	**52**	**39½**	9 to 12	**25½**	**13½**

STEEL PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	**60%**	62½%	59%
2½ to 6 in. lap welded	**57%**	59½%	56%

	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	**47%**	48½%	45%
2½ to 6 in. lap welded	**44%**	45½%	42%

Malleable fittings, Class B and C, from New York stock sell at list less 10% Cast iron, standard sizes, *32-5%* off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	New York Current	New York One Year Ago	Chicago	St. Louis	San Francisco
4 in.	**$42.00**	**$60.30**	$48.30	**$50.70**	.....	$55.00
6 in. and over	**37.50**	**55.30**	43.30	**46.86**	.....	51.00

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

Size, In.	New York Current	New York One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	**$40.00**	$50.00	.....	$50.00	.....	$55.00
4	**53.00**	60.00	$80.00	60.00	$76.50	65.00
5	80.00	90.00	.....	80.00	97.75	84.00
6	100.00	115.00	140.00	100.00	127.50	110.00
8	**160.00**	185.00	200.00	150.00	212.50	181.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	*$0.14*	**$0 096**	.....	.....	$0.12	**$0.12**	.....
4	*.14*	**096**	$0.09	$0.0875	.12	.15	$0.18
5	*.20*	**144**	.1125	.....	.18	.18	.165
6	*.20*	**144**	.135	.1225	.18	.21	.26
8	*.34*	**224**	.225	.20	.28	.30	.35
10	*.51*	**336**	.2925	.28	.42	.42	.....
12	*.65*	**432**	.3825	.36	.54	.54	.80
15	*1.05†*	**576**	.5625	.52	.72	.90	.....
18	*1.50†*	**80**	.765	.68	1.00	1.32	.....
20	*1.80†*	**96**	....	.92	1.20	.....	.....
22	*2.40†*	**1 28**	.....	.....	1.60	.....	.....
24	*2.70†*	**1 44**	1.50	1.20	1.80	2.16	2.40
27	*4.50†*	**2.60**	....	2.00	3.75†	3.00	.....
30	*5.00†*	**2.88**	....	2.45	4.75†	3.60	.....
33	*6.50†*	**3.87**	....	3.00	5.50†	.....	.....
36	*7.50†*	**4.4075**	....	3.25	6.00†	.....	.....

	3	5	8	12	24	36
Boston	$0.105	$0.1575	$0.245	$0.4725	$1.575	$4.408
Minneapolis	.....	.....	.40	.72	2.55	5.66†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.13	.....	.32½	.65†	2.34‡	.....
Los Angeles	.11*	.165*	.275	.495	1.65	.....
New Orleans	1.06*	**.159***	**.27**	.459	1.755†	.....
Cincinnati	**.096**	.144	.224	.43	1.44	4.382†
Atlanta	.09*	.135	.22	.375	1.45	.....
Montreal, *delivered*	.68‡	.45*†	.70	1.35	4.50†	.....
Detroit	**.102**	**.153**	**.238**	**.459**	**1.98†**	**6.15†**
Baltimore	.1225	.2275	.35	.6870	2.29	5.23
Kansas City, Mo	.13½	*.19*	*.30*	.....	.....	.....
Philadelphia	**.114**	**.171**	**.266**	**.513**	**1.71†**	**3.895†**

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Current	One Year Ago
New York, 45% asphalt	(at terminal)	**$0.05½**	$0.05
New York, 65% asphalt	(at terminal)	**.05½**	.05
New York, binder	(at terminal)	**.0625**	.06
New York, flux	(at terminal)	**.06**	.05½
New York, liquid asphalt	(at terminal)	**.065**	.06½
St. Louis, 30-50% asphalt (*f.o.b.*) *Wood River, Ill.*		.05	.02½*
Chicago, 40-50% asphalt		.05½	.05
Chicago, 60-70% asphalt		.05½	.05½
Dallas, 40-50% asphalt		.10	.10
Dallas, 60-70% asphalt		.13	.13
Dallas, 75-90% asphalt		.15	.15
San Francisco, binder, per ton		13.00†	15.00

* Freight $21.75 per ton to Whiting, Ind.
† F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Mexican*)	$29.00	$14.00
Boston (*Mexican*)	19.50	16.00
Chicago (*Stanolind*)	20.35	14.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	19.50*	13.00*
Dallas, (*Texas*)	35.00	27.00
Seattle "*D*" *grade* (*California*)	23.75	13.00†
Denver (*California*)	40.00	....
Minneapolis *f.o.b. Twin Cities* (*Mexican*)	33.50	28.00
St. Louis (*Mexican*)	....	....
Baltimore (*Mexican*)	18.00	14.00
Los Angeles, *at factory, Bakersfield* (*California*)	22.50	15.00
Montreal (*Mexican*)	28.00	21.00
Atlanta (*Mexican*)	22.00	17.50
Detroit (*Mexican*)	22.50	19.50
Cincinnati (*Mexican*)	22.50	19.50
Maurer, N. J. (*Trinidad and Bermudez*)	28.50	26.50
Maurer, N. J. (*Mexican*)	18.50	16.50
Philadelphia (*Mexican*)	18@20	15.00
Kansas City, *petroleum*	28.83	22.83

*Freight to San Francisco, 80c. per ton.

†F.o.b. Richmond, Cal.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums. Rebates of about $1 per bbl., no rebate for drums.

PAVING STONE—

New York *delivered*	5-in. granite, 28@29 blocks per sq.yd.	$135.00 per M
Chicago	About 4x8x4 dressed	3.20 sq.yd.
	About 4x8x4 common	3.00 sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M
Boston	5-in. granite	no report
Atlanta	Granite	2.00 sq.yd.
Detroit	Granite, 26½ blocks per sq.yd.	100.00 per M
Baltimore	Granite	2.00 sq.yd.
Montreal *delivered*	Granite	100.00 per M
New Orleans	Granite, 4 x 8 x 4	3.25 sq.yd.
Cincinnati	Granite	3.84@4 sq.yd.
St. Louis	4x8x4 dressed	3.35 sq.yd.
	4x8x4 common	3.00 sq.yd.
Kansas City	No. Granite	3.95 sq.yd.
Philadelphia	Granite	128.00 per M.

FLAGGING—

New York	Bronx	$0.25 sq.ft.
	Manhattan, 4 ft.	.26 sq.ft.
	Queens, 5 ft.	.26 sq.ft.
	6x20-in. cross-walk	1.00 lin.ft.
Chicago	18 in. wide	.99 lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 77c. for 5x16 in., 88c. for 5x18 in.; in cargo lots.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2.09
New York (*delivered*)	3½	16	2.29
New York (*delivered*)	4	16	2.57
Boston	3½	16	2.32
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50
St. Louis	3½	16	2.50
St. Louis	4	16	3.00
Seattle	4	16	Off market
Minneapolis	3½	16	2.09
Atlanta	3½	16	2.30
New Orleans	3	16	1.80
New Orleans	3½	16	2.02½
New Orleans	4	16	2.25
Dallas	4	18	3.90
Baltimore	3½	16	3.44
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	2.10
Kansas City	4	16	2.15
Philadelphia	3½	16	3@3.25

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Current	Gravel 1½ In. One Year Ago	Gravel ¾ In. Current	Gravel ¾ In. One Year Ago	Sand Current	Sand One Year Ago
New York	$1.75	$2.25	$1.75	$2.25	$1.00	$1.25
Denver	1.75	2.00	1.75	1.80	0.75	1.60
Chicago	2.00	1.80	2.00	1.80	2.00	1.80
St. Louis, *per ton*	1.25	....	1.30	....	1.10	....
Seattle	*1.00*	1.50	*1.00*	1.50	*1.00*	1.50
Dallas	2.25	3.09	2.25	3.50	2.25	2.50
Minneapolis	1.75	2.00	1.75	....	1.00	1.00
Cincinnati	1.87½	2.25	1.87½	2.25	1.43	1.69
San Francisco	2.25	2.25	2.25	2.50	1.50	1.50
Boston	....	2.65	....	2.65	....	2.00
New Orleans	2.85	2.85	2.85	....	1.35	1.35
Los Angeles, per ton	1.50†	1.35†	1.50†	1.45†	1.35†	1.20†
Atlanta, per ton	1.85	2.25	1.85	2.25	1.15	1.35
Detroit	2.00	2.00	2.00	2.00	2.00	2.00
Baltimore, per ton	1.40	1.40	1.60	1.60	2.00	2.40
Montreal, per ton	1.25	1.50	1.50	1.50	1.25	1.25
Birmingham, per ton (Crushed slag used instead of gravel)					1.28	1.37‡
Philadelphia	1.60	....	1.65	....	1.60	....
Kansas City, per ton	2.00‡	....	2.00‡	....	*0.66*	....

* Fine white sand: Pacific, $5 per ton; Ottawa, $6.

† Freight from quarry to Los Angeles is 85c. per ton, and is included in above price.

‡ Per cu. yd.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Current	1½ In. One Year Ago	¾ In. Current	¾ In. One Year Ago
New York	$1.65	$1.90@2.00	$1.75	$1.90@2.00
Chicago	1.60	2.00	1.60	2.50
St. Louis *delivered*	1.65	1.60*	1.65	1.60*
Dallas	1.65	2.80	1.65	2.80
San Francisco	2.25	2.25	2.25	2.50
Boston, *delivered*	....	3.00	....	3.00*
Minneapolis, *at plant*	2.00	2.00	2.25	2.25
Kansas City, *at plant*	2.10	1.50	2.10	1.50
Denver	3.50	....	3.50	....
Seattle *delivered*	3.00	3.00	3.00	3.50
Atlanta	1.90*	2.25*	1.90*	....
Cincinnati *delivered*	1.75	2.06	1.75	2.06
Los Angeles	1.75*	1.60*	1.85*	1.70*
Detroit	1.90*	1.90*	1.90*	1.90*
Baltimore	1.75*	1.75*	1.65*	1.65*
Montreal	*1.50**	2.00*	2.00*	2.10*
Birmingham *delivered*	3.20	3.20	3.10	3.10
Phildelphia	1.70*	....	1.55*	....
Pittsburgh	2.85	....	2.85	....
Cleveland	3.00*	....	3.00*	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.30	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
East Canaan, Conn	1.25	1.35	4.00	1.00
Easton, Catasaqua, Pa	1.00	1.00	2.00	0.90
Birmingham, Ala	*0.75*	0.75	....	0.25
Buffalo, N. Y., and Erie, Pa	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.20	1.20	....	1.00
Eastern Pennsylvania and Northern New Jersey	1.20	1.20	2.00	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$15.80@$16.17	$13.10	$3.63½*	$2.75@$3.14½*
Chicago	18.00	....	....	1.40†
St. Louis	23.20	20.00	2.35†	....
Boston	....	....	....	....
Dallas	25.00	....	....	2.50†
Cincinnati	15.10	12.50	10.75‡	12.50‡
San Francisco	22.00	*16.00*	....	1.75†
Minneapolis	29.00	22.00 (white)	1.70†	1.40†
Denver	24.00	....	....	2.70†
Detroit	18.00	16.00	....	17.00‡
Seattle *paper sacks*	24.00	....	2.80†	....
Los Angeles	30.00	30.00	3.00*	3.00*
Baltimore	15.00	13.00	....	12.00‡
Montreal	21.00	21.00	15.00‡	11.00‡
Atlanta	*22.50*	13.00	2.00†	*1.75*†
New Orleans	....	17.25	2.40†	....
Philadelphia	15.00	14.00	12.50‡	11.50‡
Kansas City	25.60	....	....	12.40†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is. white is $1.70, Sheboygan $1.55. New York quotes hydrated lime "on cars" in paper sacks; lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.60	1.60
Atlanta (Magnolia)	11.00 ton	11.00
Cincinnati (Utica)	1.77	1.87
Boston (Rosendale) per bag	....	0.95@1.05
St. Louis (Carney)	*1.87*	....

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b points listed *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York, del. by truck	$2.60	$2.40@2.50	$2.60@2.70
New York, alongside dock to dealers	2.30	2.10	2.40
Jersey City	2.73	2.28	2.89
Boston	....	....	2.86
Chicago	2.20	2.05	2.17
Pittsburgh	2.24	2.09	2.17
Cleveland	2.46	2.31	2.43
Detroit	2.48	2.33	2.43
Indianapolis	2.41	2.26	2.43
Toledo	2.53	2.33	2.49
Milwaukee	2.37	2.22	2.39
Duluth	2.14	2.14	2.10
Peoria	2.41	2.26	2.45
Cedar Rapids	2.48	2.33	2.51
Davenport	2.43	2.28	2.47
St. Louis	2.20	2.20	2.90
San Francisco	2.71	2.71	3.09
New Orleans	3.20	3.20	3.20
Minneapolis	2.39	2.39	2.41
Denver	2.85	2.85	3.10
Seattle	2.90	2.90	3.10
Dallas	2.25	2.25	2.80
Atlanta	2.50	2.50	2.75
Cincinnati	2.59	2.39	2.57
Los Angeles	3.30	3.30	3.31
Baltimore, del. by truck	2.50	2.50	2.98
Birmingham	2.10	2.10	2.85
Kansas City	2.85	2.40	3.05
Montreal	2.78	2.78	2.75
Philadelphia	2.41	2.31	....
St. Paul	2.39	2.39	2.41

NOTE—Bags 10c. each, 40c. per bbl.;

Current mill-prices per barrel in carload lots, without bags; to contractors:

Buffington, Ind.	$1.95	Mason City, Ia.	$2.35
Universal, Pa.	2.00	Hudson, N. Y.	2.10
Steelton, Minn.	1.95	Leeds, Ala.	2.30
Fordwick, Va.	2.35	Hannibal, Mo.	2.00
Mitchell, Ind.	2.35	Lehigh Valley District	2.00
Iola, Kan.	2.10	La Salle, Ind.	2.35

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh, Mill	Warehouse: New York	Chicago	Dallas	San Francisco
032	22	$0.74	$0.95	$0 86	$1.15	$1 20
049	28	.9	1.23	1 11	1.46	1 55
068	35	1 14	1 48	1 35	1.80	1 89
093	45	1 56	1 91	1 73	2.30	2 43
126	57	1 [illegible]	2.35	2 13	2.86	3 01
153	68	2 ..	2.81	2 54	3.40	.....
180	78	2 46	3.22	2 92	3.93	.....
245	103	3 24	4.25	3 85	5.15	.....
287	119	3.75	4.90	4 45	5.96	6 31
336	138	4.35	5.69	5 16	7.32	.....
395	160	5.04	6.60	5 98	8.00	.....
		PAVING				
036P	17	$0.56	$0.72	$0 66	$0.88	.....
053P	24	.79	1.02	.93	1.24	.....
072P	31	.99	1.29	1 18	1.57	.....
097P	40	1.28	1.67	1 52	2.02	.....
049R	24	.79	1.02	.93	1.24	.....
067R	31	.99	1.29	1 18	1.57	.....
089R	40	1.28	1.67	1.52	2.02	.....

In rolls 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27BB	2.3	$22 00	$20 39	$21 25	$20 78	$25 50
26BB	2.5	22 00	22.00	22 75	21 43	27 56
25BB	3.0	22 00	...	27 10	...	30 71
24BB	3.4	24 00	26 33	29 25	24 28	33 16
22PO	4.33	27 00	31.00	31 75	.....	35.10

* Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1 90@2 25	$1 85	$2 94	$2 82½	.....	$3 50	$3 00
⅝	1 95@2 30	1 90	2 99	2 87½	.....	3 55	3 05
¾	2 00@2 35	1 90	3 04	2 92½	.....	3 60	3 10
⅞	2 15@2 50	1 95	3 09	3 07½	.....	3 75	3 25
1	2 40@2 75	1 95	3 44	3 32½	.....	4 00	3 50

Includes 15c charge for cutting to lengths of 2 ft. and over. Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$1.70	....	$3 25	½	$1.95	.....	$3.50
⅝ in.	1.75	.....	3 30	¼	2.20	.....	3 75
¾	1.80	.....	3 35	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Current	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$21.30@23.50	$23.50	$18.40	$42.00†	$50.00†
New York (at dock)	18@20	20.00	15@15.50	.....	.....
Chicago	11 00	11 00	11.00	34.00	42.00
St. Louis, salmon	14 00	14 00	17 00	.....	28.00
Denver, salmon	12 00	12 00	14 00	.....	.....
Dallas	10 90	11 15	12 72	no market	
San Francisco	15 00	15 00	18 00	.....	.....
Los Angeles (del.)	15 00	15 00	15 50	(not used)	
Boston (del.)	.....	16 00	17 00	44.00†	53.00†
Minneapolis (del.)	18@19	17@18	17.00	.....	43.00
Kansas City	16 50	14 50	15 50	.....	.....
Seattle	14 00	14 00	14 00	44.00	.....
Cincinnati	15 00	15 00	19.00	41.00	36.50
Montreal	16 00	16 00	18 00	.....	68.00
Detroit (del.)	16.50	16 50	17 00	36 50	39 50@41
Baltimore (del.)	20 00	20 00	20.00	36.00‡	.....
Atlanta	11 00	11 00	10 00	38.00	.....
New Orleans	13 00	12 50	14 00	.....	.....
Birmingham	12 00	12 00	11 50	.....	.....
Philadelphia	17.50@18.50	17.50@18.50	16.50@17.50	38.00	46.00
Pittsburgh (del.)	16.00	16.00	.....	.....	.....
Cleveland	16 00	14.00	.....	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Current on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0.11120	$0.11370	$0 0808	$0 115	$0.0635	$0.108	.....
6x12x12	.16670	.15160	.1112	.....	.08	.156	.....
8x12x12	.20840	.20210	.1516	.18	.12	.244	$0.17890
10x12x12	.....	.....	.1879	.....	.16	.....	.21050
12x12x12	.....	.....	.2147	.....	.185	.....	.27370

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	.....	.....	.....
Minneapolis (f.o.b. cars)	$0 08	$0 13125	$0 23
Minneapolis (delivered)	09	.14675	.255
Cincinnati	.0670	1263	.175
Kansas City	.085	.167	.270
Denver	.087	.145	21
Seattle (delivered)	.11	.25	.36
Los Angeles factory	.095	.176	.22
New Orleans	.12	.23	.36
Detroit (delivered)	.070	.135	.225
Montreal	.09	.16	.30
Baltimore	.14	.35	.39
Atlanta	.0776	.1453	.....
Dallas	.115	.....	.....
Birmingham	.10	.17	.....
Pittsburgh (del.)	.068	.128	.179
Cleveland	08	.184	.....

San Francisco, Philadelphia, Atlanta, New York, quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	1 90@2 25	$1.95	$3 04	$4 20	.....	$2 92½	$3 25
Channel, 3 to 15 in.	1 90@2 25	1 95	3 34	4 20	.....	2 92½	3 25
Angles, 3 to 6 in., ¼ in. thick	1 90@2 25	1.95	3 04	4 20	.....	2 92½	3 25
Tees, 3 in. and larger	1 90@2 25	1.95	3 04	4 20	.....	2 92½	3 25
Plates	1 90@2 25	1.95	3 04	4 20	.....	2 92½	3 25

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Warehouse: Pittsburgh, Mill	New York: Current	New York: One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$2 65	$3 85	$4.40	$3 35	$3 09½	$4.25	$6 00

CONE HEAD BOILER

½ in. and larger	2 75	3 95	4 50	3 45	3.19½	4 35	6 15
⅝ and ¾	2 90	4 11	4 65	3 60	3 35½	4 50	6 30
⅞ and 1	3 15	4 35	4 90	3 85	3 59½	4 75	6 55

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.40@2.60	$3.10	$3.90	$5.00	$3.25	$4.95
Cut	2.25	5 50	5.65	7.75	....	5.00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square, f.o.b., as follows:

	New York: 1-Ply l.c.l.	New York: 2-Ply l.c.l.	New York: 3-Ply l.c.l.	Philadelphia: 1-Ply l.c.l.	Philadelphia: 2-Ply l.c.l.	Philadelphia: 3-Ply l.c.l.
No. 1 grade	$2.10	$2.55	$3.00	$1 90	$2.35	$2.80
No. 2 grade	1.85	2.15	2.55	1.70	2.00	2.40

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $1.95 per roll in carload lots and $2.20 for smaller quantities f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $5.50 per package (sufficient to cover 50 sq.ft.) in carloads; $5.75 in smaller quantities, in Philadelphia. Strip shingles (4 in 1) f.o.b. Philadelphia, l.c.l., $5.90

ROOFING MATERIALS—Prices f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq.ft.	$2 00
Tar pitch (in 400-lb. bbl.), per 100 lb.	1 65
Asphalt roofing (in barrels), per ton, f.o.b. plant*	40.50
Asphalt felt (light), per ton, f.o.b. plant*	64.50
Asphalt felt (heavy), per ton, f.o.b. plant*	68.50

* Delivered in Metropolitan Dist., $3.00 additional.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2 50@2.60	.....	$4 00	$4.35	$4 03
No. 12	2.55@ 2.65	.....	4 05	4.40	4 08
No. 14	2 60@ 2.70	.....	4 10	4.45	4 13
No. 16	2 80@ 2.90	.....	4 20	4.55	4.23
Black					
*Nos. 18 and 20	3 20@ 3.35	.....	.....	5.45	4 40
*Nos. 22 and 24	3 25@ 3.40	.....	4 70	5 50	4 45
*No. 26	3 30@ 3.45	.....	4 75	5.55	4 50
*No. 28	3 35@ 3.50	.....	4.85	5.65	4 60
Galvanized					
No. 10	3 35@ 3.45	.....	4 85	....	4.60
No. 12	3 45@ 3.60	.....	4.95	5.60	4 70
No. 14	3 45@ 3.60	.....	4 95	5.60	4.70
Nos. 17 to 21	3 75@ 3.90	.....	.....	5 90	5 00
Nos. 22 and 24	3 90@ 4.05	.....	5 40	6.05	5 15
*Nos. 25 and 26	4 05@ 4.20	.....	5 55	6.20	5 30
*No. 28	4 35@ 4.50	.....	5.95	6.50	5.60

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Current	New York: One Year Ago	Chicago: Current	Chicago: One Year Ago
Raw in barrel (5 bbl. lots)	$0.91	$0 78	$0 99	$0.75

WHITE AND RED LEAD—Base price in cents per pound:

	Red				White	
	Current		1 Year Ago		Current	Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil
100-lb. keg	12.50	14.00	12.25	13.75	12.50	12.25
25 and 50-lb. kegs	12.75	14.25	12.50	14.00	12.75	12.50
12½-lb. keg	13.00	14.50	12.75	14.25	13.00	12.75
5-lb. cans	15.50	17.00	15.25	16.75	15.50	15.25
1-lb. cans	17.50	19.00	17.25	18.75	17.50	17.25

LUMBER

Prices wholesale to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M ft. additional.

	6–8 and 12 Ft.	10–16–18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$28.00	$31.00	$31.00	$33.00
3x6 and 8	28.00	31.00	31.00	34.00
4x4-6 and 8	28.00	31.00	32.00	35.00
3x10 and 12	28.00	33.00	32.00	36.00
3x14	32.00	33.00	34.00	36.00
4x10 and 12	28.00	31.00	32.00	35.00
4x14	32.00	33.00	34.00	36.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft
6x10	$30.00	$33.00	$35.00
6x14	32.00	35.00	37.00
8x10	30.00	33.00	35.00
8x14	32.00	35.00	37.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22–24 Ft.	20 Ft. and Under	22–24 Ft.
3x 4 to 8x8	$44.00	$45.00	$43.00	$45.00
3x10 to 10x10	46.00	47.00	46.00	48.00
3x12 to 12x12	48.00	49.00	49.00	51.00
3x14 to 14x14	54.00	55.00	54.00	56.00
3x16 to 16x16	60.00	61.00	58.00	60.00
3x18 to 18x18	68.00	69.00	65.00	67.00
4x20 to 20x20	78.00	79.00	75.00	77.00

*Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine up to 14 x 14 costs $15 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities	8 x 8-In. x 20 Ft. and Under				12 x 12-In. 20 Ft. and Under	
	P.	Fir	Hemlock	Spruce	P.	Fir
Boston						
Seattle		$23.00				$23.00
New Orleans	$30.00				$35.00	
Baltimore	36.45				38.50	
Cincinnati	39.00	50.00			40.00	64.00
Montreal	50.00	50.00	$35.00	$38.00	78.00	50.00
Los Angeles		44.00	43.00			44.00
Denver		36.25	36.25	36.25		50.00
Minneapolis	47.00	41.00	42.00		49.00	41.00
Atlanta	35.00				40.00	
Dallas	37.50				40.00	
Kansas City	39.25				48.25	
Birmingham	32.00				36.00	
Philadelphia	39.00	39.00	44.00	50.00	48.00	39.00
Detroit	43.75	47.75			51.75	46.75
St. Louis	35.00				38.00	

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir	Hemlock	P.	Fir
Boston					
Seattle		$15.50			$16.50
New Orleans, at mill	$70.00			$37.00	
Baltimore	35.00			36.45	
Cincinnati	62.50	80.00		33.50	
Montreal	66.00	45.00	$27.00	45.00	45.00
Los Angeles		37.00	36.00		43.00
Denver		34.25	34.25		33.25
Minneapolis	46.50	40.25	38.25	43.75	40.25
Atlanta	22.00			26.00	
Dallas	37.50	30.00		40.50	
Kansas City	71.50			39.50	
Birmingham	28.00			30.00	
Philadelphia	32.00	37.50	45.00	34.00	37.50
Detroit	44.25	36.50		41.00	39.00
St. Louis	36.00			35.00	

Montreal—Up to 32 ft.; over which, $3.00 per M. increase up to 30 ft.

Birmingham—Quotes carload lots, f.o.b. sidings. $2.00 additional per M. ft to contractor.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers prices to contractor on large projects.

St. Louis—Wholesale price to contractors, $4.50@$6 per M ft. additional.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.315	Detroit	$0.295
Birmingham	.69	Kansas City	.735
Boston	.365	New Orleans	.515
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.50†
Cincinnati	.295	Philadelphia	.325
Cleveland	.215	St. Louis	.43
Denver	1.275*	St. Paul	.595

*Minimum carload, 40,000 lb.

†Minimum carload, 50,000 lb., structural steel only; 80,000, lb. for other iron or steel products.

CONTRACTORS' SUPPLIES

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$2.35	$1.65@1.85	$2.00

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Hercules red strand, all constructions	30%
Patent flattened strand, special and cast steel	30%
Patent flattened strand, iron rope	15%
Plow steel round strand rope	45%
Special steel round strand rope	40%
Cast steel round strand rope	32½%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	—%

California, Oregon, Nevada and Washington Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft., ½-in., 6; ⅜-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston		New Orleans	$0.17½
New York	$0.17	Los Angeles	.16½
Chicago	.19	Seattle	.18
Minneapolis	.19½	St. Louis	.21
San Francisco	.17	Montreal	.30
Atlanta	.21	Detroit	.19
Denver	.20	Baltimore	.20
Cincinnati	.20	Kansas City	.18½
Dallas	.29	Birmingham	.20½
Philadelphia	.18½		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.29	$0.32
Boston		
Kansas City	.2425	.2725
Seattle	.175	.195
Chicago	.2450	.2750
Minneapolis	.2092	.2295
St. Louis	.2475	.2775
Denver	.1775	.2075
Dallas	.29	.375
Los Angeles	.23	.26
Atlanta	.2525	.2825
Baltimore	.2550	.27
Cincinnati	.2350	.255
Montreal	.195	.235
Birmingham, *delivered*	.195	.235
New Orleans	.2675	.3025
San Francisco	.195	.235
Philadelphia	.24	.27

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.13	$0.17½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	0.17½	0.22
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	0.19½	0.24
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	0.23	0.32
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	0.25	0.34
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	0.32	0.38

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$12.50	$11.50	$12.00
Stove plate	13.50	12.00	13.50
No. 1 machinery cast	17.00	16.50	14.50
Machine shop turnings	7.00@7.50	4.00	5.00
Cast borings	11.00	5.50	6.75
Railroad malleable cast	14.00	12.50	10.25
Re-rolling rails	13.00	13.00	15.00
Relaying rails	28.50	30.00	15.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco Galv.	San Francisco Black	Seattle Black
½	$6.75	$5.50	$8.55
⅝	6.30	5.05	8.25
¾	6.15	4.90	8.30

Pittsburgh base in lots of 200 kegs or more $3.25